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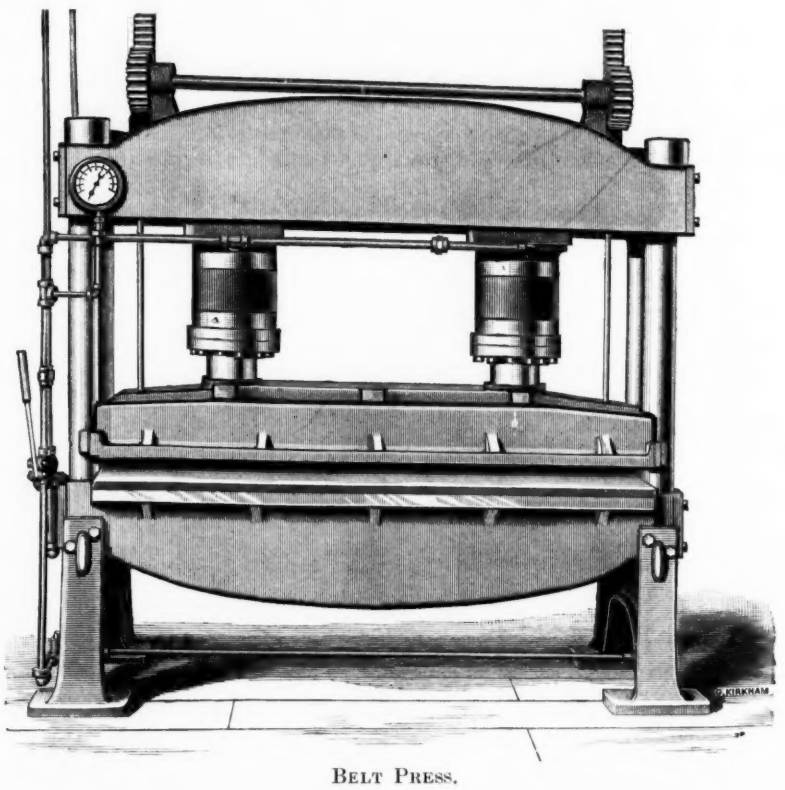
Belt Press.

The illustrations on this and the succeeding page are of a hydraulic press, built by Watson & Stillman, of this city, for Fayerweather & Ladew, belt manufacturers, and is used by them for pressing the laps of leather belts in cementing them. The press is designed for belts up to seventy-eight inches wide, and to exert a pressure of 300 pounds per square inch of belt surface, this being the pressure determined upon as best for cementing laps. The pressure gauge is numbered to indicate when this pressure has been reached for belts of different widths regardless of the pressure on the rams, so that it is only necessary to watch the gauge, and when the figure corresponding to the width of the belt being operated upon is reached, it is known that the pressure—300 pounds per square inch of belt surface—has been reached.

On the lower platen is placed a sheet of pure rubber, one inch in thickness, on which the belt is placed. The upper platen, which has a movement of six inches, is forced down upon it by the large rams seen above the press, being driven by a "two plunger variable delivery belt-driven pump," with special attachments for stopping the action of the press at any desired point without shifting the belt. The large compressing rams are not fixed rigidly to the movable platen, but their lower ends merely rest in sockets prepared for them, the weight of the platen being sustained by small hydraulic pistons working in cylinders placed in the frame of the machine at either end under the movable platen. By a valve shown at the left of the machine, and which is controlled by a lever, the pressure can be at any time thrown from the upper large cylinders to the small ones below, when the platen is quickly raised to its full height, though, of course, its motion in either direction can be stopped or reversed at any point. The two small rods seen connected to the platen are also connected to the short racks seen above, which are made to move together by means of the pinions and connecting cross shaft, the object being to cause the platen to have a uniform motion at each end. It is found that where two hydraulic rams act upon a single platen in this way, if one or the other of the rams moves with slightly more friction than the other, or meets with slightly more resistance than the other, it stands still, the other ram doing all the moving until it meets sufficient resistance to overcome that encountered by its fellow. It is the purpose of these rods and the racks to overcome any such difference in frictional or other resistance as may occur.



BELT PRESS.

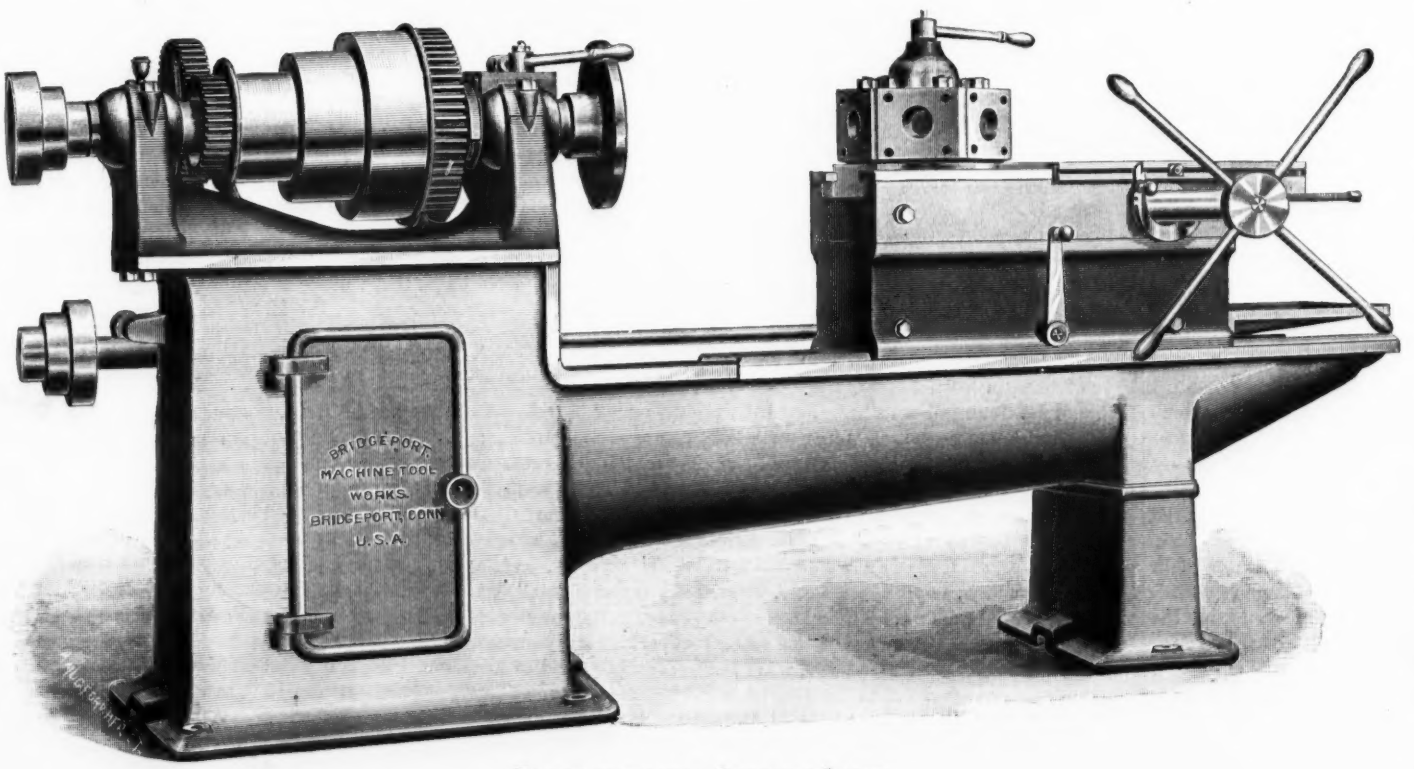
A safety coupling is put in below the pressure gauge, which is so arranged that, when the pressure is suddenly removed from it, the hand is allowed to go back gradually, and the gauge is relieved of the sudden shocks which it might otherwise receive. Our detail cuts, which are made from working drawings, show the construction of the press, which in operation has proven very efficient. It weighs about 15 000 pounds, a smaller one for belts up to sixty inches wide weighing about 12,000 pounds.

It seems not improbable that steel is to make one more important conquest over wood for use on railroads, by the substitution of steel ties for wooden ones, and that the day is not far distant when we shall have steel locomotives, drawing steel cars over steel rails, fastened to steel ties or laid over steel bridges. Some of these things we have now, and the others are coming. The substitution of steel for wooden ties will stop a serious drain on our American forests, which are undoubtedly being cut away too rapidly in many quarters. But it is to be hoped that this is not the only advantage to be gained, but that a tie may come into use which will make the rails more secure, and thus tend to greater safety and economy in the operation of roads. It does not seem unreasonable to expect that this will be done. It is claimed for steel ties, that by their use there will be less danger of displaced rails than with wooden ties, which, in view of the fact that steel does not rot, seems to be a claim with a reasonable foundation.

Our English friends are clamoring for cheaper railroad freights. Freight tariff in England largely exceeds that in the United States; still "labor is cheap in Europe."

New Thirty-seven-inch Chucking Machine.

We give herewith an illustration of a turret-head chucking machine, capable of swinging work up to thirty-seven inches diameter, the bed being eight feet long. The form of bed in this machine is a novel feature, being such as to secure the greatest rigidity and strength for the metal used, and the bed and cabinet being cast in a single piece, the weight and strength of which makes it an excellent and exceptionally rigid support for the working parts of the machine. A "well-hole" is cast through the bed, affording a free passage for chips. The outer support is also made in cabinet form with shelves cast in, the two closets thus formed giving ample space for all tools and appliances usually required in operating such a machine.



THIRTY-SEVEN-INCH CHUCKING LATHE.

The head is back-geared, with ample power for the heaviest work done on such a machine. The cone pulley is for a 4-inch belt, the largest step 14 inches diameter. A 2½ inch hole passes through the spindle. For throwing the back gear in or out of action there is a patent clutch which accomplishes this without stopping the machine. It is operated by the lever seen over the main bearing. The turret is hexagonal in form, permitting tools or fixtures to be bolted to the flat faces when desired,

holes being drilled for the purpose. It is 12 inches diameter, with six 2½-inch holes, and is provided with automatic feed and stop motion. The turret is automatically revolved, and locked by the backward motion of the slide, and there is an arrangement by which this action can be made to take place at any point in the travel from 6 to 14 inches, thus obviating the necessity for giving the full movement of the slide when doing short work.

A removable chucking rest is attached to the turret base, and is fitted with suitable bushings, which steady the bar or drill.

The design of this machine will, we think, meet the approval of those competent to judge of such matters; and, as might be expected, the machine has proven very efficient in service.

It is built by the Bridgeport Machine Tool Works, Bridgeport, Conn.

Working of Railroads by Electricity.

By WILLIS E. HALL, ALTOONA, PA.

(A Paper Presented at the Cincinnati Meeting of Mechanical Engineers.)

All innovations are taken up and accepted but slowly, and it is generally only through the continual driving of stubborn facts that we are willing to step (and then often reluctantly) from the beaten paths and ruts of our ancestors. All of this is better than to inaugurate a revolution, or attempt to divert a mass of moving bodies from one direction to its opposite, or in any other way which would prevent the operations of our every-day life from continuing with undiminished vigor and efficiency. But if once we stand still we become stagnated, and while nothing is to be gained by stopping or visibly checking the maintenance of an attained condition, yet there is no reason why development and maintenance should not go hand in hand, to the advantage of both sides. So when people predict changes and advancements of a few years hence we must not reject them with a feeling and criticism that such would not be applicable to our "working of to-day," but rather stop to consider if our present methods could not be gradually altered to accept the new plan, provided it promised any better or more satisfactory results. With this as a preliminary, it is asserted that the day is not far distant when we will see the railroads, generally known as steam lines, run by electricity from a central station. This is not, doubtless, the first time such an assertion has been made; but I have not as yet seen any discussion of the subject which has more than insinuated the advantages which would result in the operation of railroad lines by such a concentration of power. From a lack of time no attempt is made to analyze the two methods in a mathematical way, but rather it is aimed to point out some of the many advantages which the use of electricity allows, and which will inevitably result in operating a long line.

With this object let us take a few of the changes which the substitution of centralized electricity would inaugurate when used in place of the present system of locomotives.

One very important gain would be the concentration of the power at one point, for a given length of line, into a few cylinders, instead of working it in a number of isolated engines where the insulation is poor and the chances for condensation the best. A number of central stations—located, say, at a distance of 30 to 40 miles apart—could be run by large, powerful engines, and the expansion of the steam worked at an economical point by better and more mechanical means of cut-off than can be obtained in the present type of locomotive construction. With locomotives the ratio of expansion at low speeds is correspondingly poor, nor can we expect to make an efficient engine of it, except in one working condition which is dependent upon the concurrence of so many variables that the engine is never worked in that ratio for any length of time. With stationary engines, however, the case is the reverse, as such are designed to work at a constant speed, and if properly proportioned would be utilized at the highest grade of expansion consistent with economy. This point would not vary much, as experience with hydraulic and electric plants would indicate. The fluctuations in the case of a railroad line would probably be even less, as the working is generally uniform throughout the twenty-four hours of the day. It would be a case of a properly loaded automatic cut-off engine against the equivalent of a similar engine vacillating between an over to an under load, and such range of the broadest nature. We must not lose sight of the fact that the question of keeping the line clear is properly held as of higher value in a closely worked system than is the consumption of coal which may result per the horse-power, which the engine is to develop to reach its destination as scheduled. In furtherance of a reduction in coal consumption, the use of condensing—and possibly compounding—at a central station would raise this part of the working of the line to the highest grade of efficiency.

In experiments recently made it was found that an electric motor could climb a grade of over fifty per cent., which is far beyond the point of adhesion of locomotives; so that in this direction we could look for a marked improvement. An analysis of the conditions in the two cases will disclose the reason for this, and no doubt all who have had any experience with engines which were overloaded or which slipped their drivers easily will appreciate its importance.

The question of attainable speed enters as a factor, for the speed to which an engine can safely be driven is known to have its limits—and which, to all appearances, we are now closely approaching. The piston speed of an engine with 24 inches stroke and 68 inches diameter of driving-wheels, traveling at 60 miles per hour, would be about 1,400 feet per minute. An increase in the diameter of driving-wheels, with the object of decreasing the number of strokes, makes the engine correspondingly weaker, so that two sharp horns of a dilemma are placed before him who attempts to design an engine to haul the increasing weight of trains at a high speed. The questions of parts and velocity of steam are mentioned in passing. The resistance of trains is now quite positively known to increase about with the square of the velocity, which would enter as a function in the power to be given to a motor to drive a train at a desired speed. With such a means, however, the speed is limited only by the power which is given in its design, and is determined more by what the conditions of the service will stand.

With electric motors it would not be necessary to have track-tanks and water standpipes distributed closely throughout the line, which means considerable to those who are acquainted with the attention and repairs (especially through the winter season) which such arrangements demand. The delay, too, where freight engines are not equipped with water scoops, is apparent, and even this latter method of filling tanks is beginning to show its effects upon the schedule which it is possible to make on lines which are worked closely to their limit. Nor would it be necessary to carry the dead weight of tender with contained water, which is hardly as easy an accompaniment as its name would imply. In this connection it might be well to mention the annoyances from cleaning fires, as is required in freight service where the division is a long one. The experience with the centralization of power where large hydraulic, electric or pneumatic plants are in operation, is that a greater amount can be supplied than it is necessary to develop at the station—that is, where there is much division (such as would be the case when the power is distributed through commercial districts and divided into small parts) a 50 to 60 H.P. plant can take and supply satisfactorily about 100 H. P. In railroad work such a ratio could hardly be looked for, as the number of trains would not be as large as the division where the power is distributed for mercantile and commercial purposes; but a reduction of some 25 per cent. can safely be counted upon. The reason for this is evident, as it never occurs that all the power will be used simultaneously which each division is capable of exerting. With railroads, too, it will not occur that all trains would be exerting their maximum power, such as, for instance, climbing heavy grades at the same time.

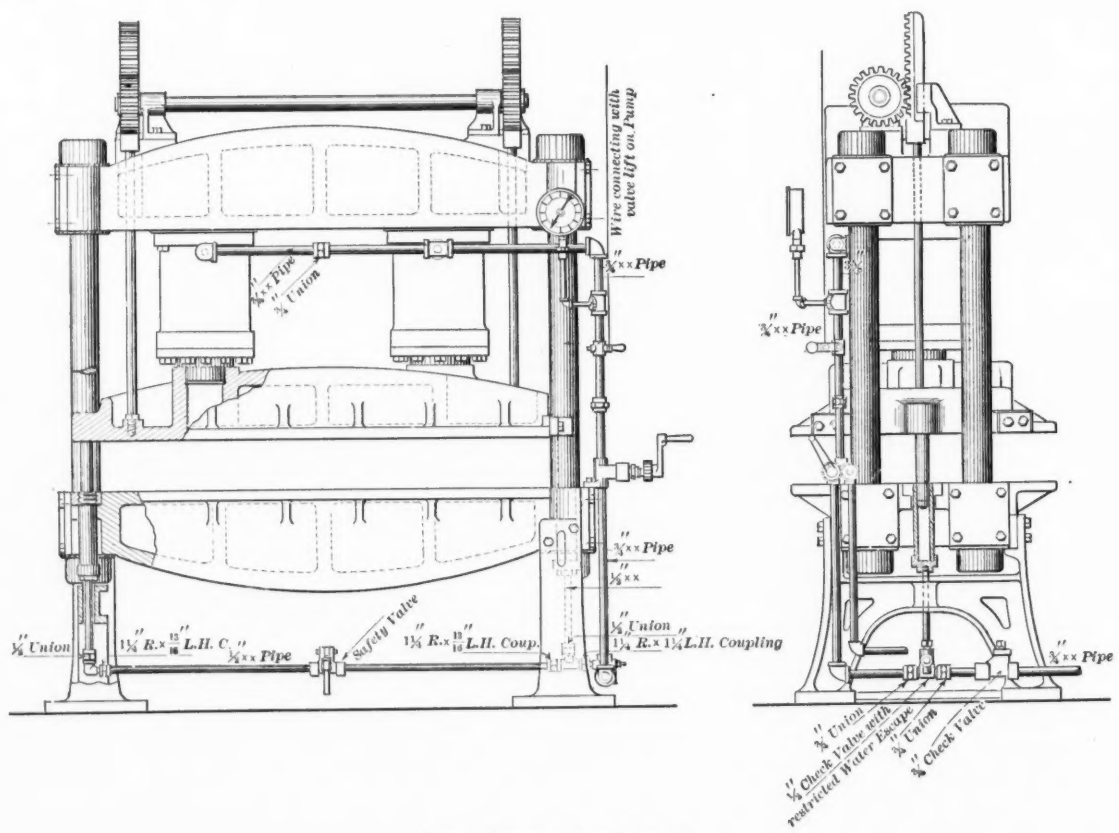
The best kind of mechanical ingenuity and high efficiency of any mechanical design which is made to accomplish a given object are dependent, principally, upon reducing the number of parts which it contains, so long as the desired result is obtained. Multiplication of parts increases the number of pieces to wear, and consequent repairs, as well as the chances of failure from breakage. No argument is necessary to indicate the advantage which electric motors would have over the present design, or over any other design of locomotive where all the requisites of an engine must be incorporated in so many isolated places. The failures from leaky flues, broken eccentric strap knocking a hole in the fire-box, blowing or knocking out cylinder-heads, and the multitude of accidents which are happening every day on railroad lines, would be decreased to a marked extent. The reduction in the internal friction of the driving mechanism is also apparent.

No comparative mention has been made of the cost of repairs, the too large percentage of power which is idle to have this work done, the reduction in the number of motors required to make the same train mileage (due to more uniform and consequent higher average speed, resulting in a reduction of time to go over a length of line), together with the loss of coal from irregular working of engine and boiler where the line is undulating, as is the case with all to a greater or less extent; also the attention and care which a large number of isolated boilers demand to keep them in a safe working condition, as well as the rapid wear of machinery where it is exposed to out-door influences, such as dirt and the elements, as is the case with locomotives. In fact, the elimination of such details could be extended almost indefinitely, and in them there would appear visions of a removal of a mass of the little annoyances from the shoulders of those who are now held responsible for the maintenance of this accumulation of complications.

The loss in electric transmission has not been neglected, which, in a station controlling a line of, say, 30 miles, would, at the present state of the science, amount to some 50 per cent.—which includes loss in dynamo, line, and the loss from an average working of motor. This, together with the cost of necessary plant as capital, comprise the two main objections against the introduction of electricity for transportation purposes.

No attempt is made to take up the advantages or disadvantages (as shown by mathematical calculation) resulting from such a system, but it is merely desired to mention some of the many practical points which would be met, eliminated or improved upon by the substitution of electricity to general railroad working. Nor is it that its introduction is anticipated within a year or two; but we cannot but acknowledge that the application of electricity is becoming more general, and, from the rapidity of its development, its use for such purposes is hardly more distant than the most sanguine of its advocates would predict.

The combination of electrical with mechanical engineering will bring about as much of a revolution in the future as it has done in the past; but in all its applications we must expect to see it creep before we may see it walk. A more thorough intermingling of the mechanical, however, would hardly be a detriment to much of the so-called electrical engineering.



BELT PRESS.—SEE PAGE 1

Forced Draught in the British Navy.

Naval officers are not remarkable for unanimity of opinion. What they had to say during the discussion at the Institution of Naval Architects on Mr. White's paper is the more striking. It will have been seen by those who have read our report of the meeting, that admirals and captains alike drifted away from other subjects and concentrated their energies on discussing forced draught.

Several points of considerable importance were settled, one being that the use of forced draught is now to all intents and purposes prohibited in the navy. All the appliances for its use are there—fans, engines, closed stokeholds, and air locks; but these things are not to be used save for the purpose of supplementing the funnels. These in ships of war are kept short. The air finds considerable difficulty in making its way into the recesses and depths of the ship, and so, in order that steam may be kept up, the fans must be run. On the measured mile once in a ship's commission, forced draught may be used to such an extent that an air pressure equal to one inch of water will be maintained in the stokeholds. Again, if a ship has to run away from a foe, resort may be had to what is regarded as a desperate remedy, but nothing more than this is sanctioned. One gallant admiral very truthfully said that there was a strict analogy between using forced draught and sitting on a safety valve. If a captain had to run for his life, and had boiler power enough, he could no doubt screw down his safety valves in order to go faster, taking his chance that his boilers would bear the extra stress. It seems that it would be much safer to carry 200 pounds pressure in a boiler ordinarily working at 150 pounds, than to work it for three or four hours with two inches water pressure. In one word, forced draught at sea is, in her Majesty's Navy, a total failure. There is nothing to be gained by glossing over the facts. There is something to be gained by recognizing their existence, and seeking out the cause of the failure and its remedy.

The nature of the failure is very simple. The tubes all leak at the combustion chamber end if the fires are urged by fans beyond a certain point. Why do they leak? Mr. Seaton, during the discussion on Mr. White's paper, pointed out that he came to London from the North to attend the meeting behind an engine which worked with forced draught, but the tubes were not expected to leak in consequence of the forced draught. It is certain that without forced draught the work of our railways could not possibly be carried on. The rate of combustion on a locomotive fire-grate is twice that which obtains in a marine boiler pushed by forced draught as hard as possible. The temperature in the furnace of a locomotive ought to be higher than that in the combustion chamber of a marine boiler. The marine boiler being worked with pure water, the tube-plates are clean; but this is not quite true of any locomotive. In all cases a little lime will be found on its plates and tubes, but this does not appear to do any harm. In what does the cause of the difference in results reside? That there is a difference and a cause is clear. In the first place there is a difference in the form of the two boilers, but, so far as can be seen, save in one respect, this difference ought to be in favor of the marine boiler. There is in the latter a longer run than there is in the former, for the products of combustion before they reach the tubes, and they ought to be cooler. We believe, however, that this is not true; at least, in so far as the tube-plate is concerned. In the locomotive a brick arch is always interposed between the grate and the tube-plate. This protects the tube-plate in large measure from the radiant heat of the fuel. The tube-plate is so closely pierced with holes that there is very little of it left, and the flame turning over the top of the brick arch is shot straight at the mouths of the tubes, so to speak; and in so far the plate itself is spared something. Now, in the marine boiler the case is very different. It is highly probable that when forced draught is used the ignition of the gases is not complete until mixture with the air has been perfected by the baffling, and twisting, and change of direction which occurs in the combustion chamber, has taken place. It is probable that, after all, the temperature in a combustion chamber may be higher than in a locomotive furnace; higher, indeed, than it is in any other part of the boiler. Again, the flame is not directed straight into the tubes; it curls along the tube-plate, flowing up it and licking it closely. The most powerful impact of the flame will be directed against the top edges of the tubes, and just within them, so to speak, while the bottom edges will to a certain extent be spared. This will tend to produce distortion of form in the tube. Again, we find that in a locomotive the tube-plate is almost invariably of copper. This is an indolent metal with no particular will of its own, and as the tubes expand and contract in length, it follows them willingly enough. Indeed, there is so little of it left that there is nothing to stand up against the push or pull of the tubes. Attempts have been made in this country to use steel or iron tube-plates, but they have invariably ended in failure. They are, it is true, used in the United States, but they can only be got to stand by making them very thin. Steel tube-plates only $\frac{3}{8}$ inch thick have been, it is said, got to do very well; but we know nothing of such thin tube-plates in this country. The tube-plate of a marine boiler is of steel, never less than half-inch thick, usually thicker. The tubes are of comparatively large diameter, and spaced widely, and many screwed stay tubes are put in. The result is that we have an extremely rigid plate. When a boiler tube alters its length, either of three things must happen. The tube-plate must breathe in and out, following the tubes, or the tubes must slip in the plates, or both actions will take place: there will be a little breathing and a little slipping. It is easy to see that a struggle will be fought out between each tube and the plate. If the tube is wedged in very tightly, then the plate must breathe. If the tube is not wedged tightly, then it will slip. If it slips it will leak. Now, the tubes in a marine boiler weigh a great deal. At 5 pound to the square foot the tubes alone in a big marine boiler will weigh five tons. When weight has to be cut down to the lowest limit, the engineer is strongly tempted to use thin tubes, and accordingly the tubes in naval boilers are one, or sometimes two, gauges thinner than in mercantile marine boilers. But it is very well known that it is a difficult job to keep a thin tube tight, unless it is also a small tube. In other words, the tubes cannot be wedged fast in the tube-plate. The expander sets out a ring just inside the plate. The tube lengthens, and as this ring cannot be driven through the plate, the plate has to go. The boiler will remain tight for such a time as the tube is kept long. The fire door is opened, there is a rush of cold air; the flame is probably extinguished for the moment in the combustion chamber, the tubes instantly contract, but the stiff tube-plate obstinately refuses to return, and the tubes slip back through the plate; the collar is no longer forced up against the edge of the holes, and there is a leak. All this ought to be well known, but it seems to be forgotten. Perhaps it is no one's business in particular to know it, or, knowing it, to act on the knowledge.

We find, then, that there is no real analogy, such as Mr. Seaton desired to draw, between the locomotive and the marine boiler. The former has a mere basket of a tube-plate; a flexible skeleton which can move in and out an eighth of an inch or so without seriously distressing itself or the tubes. Again, locomotive tubes are almost always made of either brass, or copper with brass ends. Iron tubes are used, but only to a limited extent, and never in the very best practice. They can be made to answer for goods engines. The brass tubes are much thicker in proportion to their diameter than the iron tubes of a marine boiler are. They are, therefore, more easily wedged in tightly, and it is not impossible that copper will take a tighter hold, so to speak, of a brass tube, than steel will take of a steel or iron tube. On the other hand, a locomotive boiler tube is much longer than a marine boiler tube. It is by no means certain, however, that this means that the total expansion of the former must be much greater than that of the latter. Indeed, we are strongly disposed to think that the fact that the metal of the marine boiler tube must be hotter than the metal of the locomotive boiler tube may equalize matters in this respect. But it is well known that locomotive tubes will leak now and then, and to prevent this the late Mr. Stroudley always cambered his tubes. Thus a tube 11 feet long, and 2 inches in diameter, was bent 2 inches out of the straight. This gave flexibility.

The deductions to be drawn from all that we have endeavored to put before our readers are very simple. It is essential that the tube-plate shall be flexible either at the back or the front end. In ordinary practice the front tube-plate of a marine boiler is enormously stiff, being, indeed, the front plate of the shell proper. In this respect, again, the marine boiler is much worse than the locomotive, which has two flexible plates, one at each end of the tubes. There is no reason why a thin tube plate should not be used on the front end of marine boilers. There is, indeed, room enough in them to permit special arrangements for securing flexibility to be employed. Thus, for example, a stamped steel plate, corrugated round the edges, might be used. In the second place, it seems to be desirable to use copper as the material for the back tube plate. The question of expense should not come into consideration at all. In the third place, it seems to be desirable to fit something equivalent to the brick arch of the locomotive in the combustion chamber, in such a manner that the flame would not be permitted to lick the tube-plate, but would be directed so that it would flow more in the right line of the tubes.

Mr. Fothergill pointed out that he had a considerable number of forced draught marine boilers at work with success; so has Mr. Howden. But, as we have endeavored to show, there are points of difference between the boilers used in the Navy and the merchant service, which, although apparently small, render them non-comparable. Mr. Fothergill, too, uses a very moderate draught, less than one inch of water. This ought to be perfectly safe, and apparently is. Both Mr. Fothergill and Mr. Seaton dwelt on the cold air difficulty when closed stokeholds were used. It would exceed the limits of space at our disposal to attempt here the discussion of the vexed questions of closed stokehold *versus* closed ash-pit. It must not be forgotten that Mr. Yarrow has been perfectly successful with the first, but it is noteworthy that he did not achieve success until he had adopted special precautions for letting his tube-plates breathe. Finally we may say for ourselves that we believe that forced draught can be made quite successful in the Navy, but success will not be attained by trying to stick fire-clay on a tube-plate, but by taking stock of the causes which induce leakage and eliminating them. Any marine boiler that will fit into a given limited space will not do for forced draught.—*The London Engineer.*

Odontics, or the Theory and Practice of the Teeth of Gears.

By Geo. B. Grant.

FOURTH PAPER.

48.—THE FRICTION OF APPROACH.

When the point of action between two teeth is approaching the pitch point, that is, when the action is approaching, the friction between the two tooth surfaces is greater than when the action is receding. This extra friction is always present, but is most trouble-

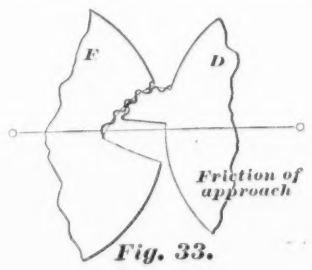


Fig. 33.

some when the surfaces are very rough, as on cast teeth, giving little trouble when the teeth are properly shaped and well cut. When the roller pin gear (93) is used, the friction between the teeth is rolling friction, and is no greater on the approach than on the recess.

The difference in the friction is probably due to the difference in the direction of the pressure between the small inequalities to which all friction is due. When the gear *D*, Fig. 33, is the driver, the action between the teeth is receding, and the inequalities lift over each other easily, while if *F* is the driver, the action is approaching, and the inequalities tend to jam together.

In the exaggerated case illustrated, it is plain that the teeth are so locked together that approaching action is impossible, while it is equally plain that motion in the other direction is easy. The same action takes place in a lesser degree with the small inequalities of ordinary rough surfaces.

The action of the common friction pawl, which works freely in one direction and jams hard in the other, is upon the same principle. A weight may be easily dragged over a rough surface that it could not be pushed over by a force that is not parallel to the surface.

The extra friction of approaching action can be avoided by giving the driver the longest face. When the driver has faces only, and the follower has only flanks, the action is particularly smooth.

Teeth that are subject to excessive maximum obliquity, such as cycloidal teeth, should not be selected for rough cast gearing, for it is the maximum rather than the average obliquity that has the greatest influence.

49.—EFFICIENCY OF GEAR TEETH.

Much has been written, but very little has been done to determine the efficiency of the teeth of gearing in the transmission of power, and therefore but little of a definite nature can be said. The question is mostly a practical one, and should be settled by experiment rather than by analysis.

The only known experiments upon the friction of spur gear teeth are the Sellers experiments, more fully detailed in (112), and but one of these relates to the spur gear. From that one it is known that a gear of twelve teeth, two pitch, working in a gear of thirty-nine teeth, has an efficiency varying from ninety per centum at a slow speed to ninety-nine per centum at a high speed. That is, an average of five per centum of the power received is wasted by friction at the teeth and shaft bearings. This result is probably a close approximation to that for any ordinary practical case.

Although theory can do nothing to decide such a question as this, it can do much to indicate probable results.

If a pair of involute teeth, for example, move over a certain distance, w, either way from the pitch point, the distance being measured on the pitch line, they will do work that is theoretically determined by the formula:

$$\text{work done} = \frac{f\,P}{2} \cdot \frac{k \pm h}{k\,h}\, w^2$$

in which f is the coefficient of friction, P is the pressure, and k and h are the pitch radii of the gears. The positive sign is to be used for gears in external, and the negative sign for those in internal contact.

The loss by friction, as shown by the formula, decreases directly as the diameters increase, the proportion of the diameters being constant.

The loss increases rapidly with the distance of the point of action from the pitch point. When the contact is at the pitch point the teeth do not slide on each other, and there is no loss, but away from that point the loss is as the square of the distance in this case, and in a still greater proportion in the case of the cycloidal tooth. Therefore a short arc of action tends to improve the efficiency.

It has been satisfactorily determined that the loss is greater during the approaching than during the receding action. This is not shown by the formula, but it may be laid to a variation in the coefficient f.

The formula shows that the loss is independent of the width or face of the gear, and therefore strength can be increased by widening the face, without increasing the friction.

If the work of internal gearing is compared with that of external gearing of the same sizes, the losses are in the proportion,

$$\frac{k - h}{k + h},$$

so that the internal gear is much the more economical, particularly when the gear and

pinion are nearly of the same size. If the gear is twice the size of the pinion the loss is but one-third of the loss when both gears are external.

Small improvement can be effected, by putting a small pinion inside rather than outside of a large gear. A six-inch pinion working with a six-foot gear has but 1.18 times the loss by the same gears, when the gear is internal.

Theoretical efficiency is discussed at great length in the Journal of the Franklin Institute, for May, 1887. Also by Reuleaux, and again by Lanza, in the Transactions of the American Society of Mechanical Engineers for 1887, and the discussion has been carried far enough.

A series of experiments with gear teeth of various sizes and forms, of various metals, would add greatly to our knowledge of this important matter.

A true determination of the efficiency of the rough cast gear, as compared with that of the cut gear, would tend to discourage the use of the former for the transmission of power, for experiment would undoubtedly show that the power wasted by the cast gear would soon pay the difference in cost of the better article.

50—STRENGTH OF A TOOTH.

The strength of a tooth is the still load it will carry, suspended from its point, and is to be carefully distinguished from the horse-power, or the load the gear will carry in motion.

The strength of a substance is not a fixed element, but will vary with different samples, and with the same sample under different circumstances, allowance must be made for the amount of service the sample has seen, concealed defects must be provided against, and therefore nothing but an actual test will surely determine its character.

Although no possible rule can be depended upon, the ultimate or breaking strength of a standard cast-iron tooth, having an addendum about equal to a third of the circular pitch, will average about three thousand five hundred pounds multiplied by the face of the gear and again by the circular pitch, both in inches.

But a tooth should never be forced up to its ultimate strength, and the best practice is to give it only about one-tenth of the load it might possibly bear, so that the following rule should be used. Multiply three hundred and fifty pounds by the face of the gear, and again by the circular pitch, both in inches, and the product will be the safe working load of one tooth.

Example: A cast-iron gear of one inch pitch, and two inches face, will safely lift $350 \times 2 \times 1 = 700$ pounds, although it would probably lift 7,000 pounds.

When there are two teeth always in working contact, it is safe to allow double the load, but care must be taken that both teeth are always in full contact.

A hard wood mortised cog has about one-third of the strength of a cast-iron tooth; steel has double the strength; wrought-iron is not quite as strong.

A small pinion generally has teeth that are weak at the roots, and then it will increase the strength to shroud the gear up to its pitch line, but shrouding will not strengthen a tooth that spreads towards its base, like an involute tooth, and when the face of the gear is wide compared with the length of the tooth the shroud is of little assistance.

It does not increase the strength of a tooth to double its pitch, for when the pitch is increased the length is also increased, and the strength is still in direct proportion to the circular pitch, while the increase has reduced the number of teeth in contact at a time.

Cut gears and cast gears are about equal as to actual strength, with the advantages in favor of the cut gear, that hidden defects are likely to be discovered, and that it is not as liable to undue strains on account of defective shape.

The rules for strength must not be used for gears running at any considerable speed, for they are intended only for slow service, as in cranes, heavy elevators, power punches, etc.

51.—HORSE-POWER OF CAST GEARS.

The horse-power of a gear is the amount of power it may be depended upon to carry in continual service.

It is very well settled that continual strains and impact will change the nature of the metal, rendering it more brittle, so that a tooth that is perfectly reliable when new may be worthless when it has seen some years of service. This cause of deterioration is particularly potent in the case of rough cast teeth, for they can only approximate to the true shape required to transmit a uniform speed, and the continual impact from shocks and rapid variations in the power carried must and does destroy the strength of the metal.

There are about as many rules for computing the power of a gear as there are manufacturers of gears, each foundryman having a rule, the only good one, which he has found in some book, and with which he will figure the power down to so many horses and hundredths of a horse as confidently as he will count the teeth or weigh the casting.

Even among the standard writers on engineering subjects the agreement is no better, as shown by Cooper's collection of twenty-four rules from many different writers, applied to the single case of a five-foot gear. See the "Journal of the Franklin Institute" for July, 1879. For the single case over twenty different results were obtained, ranging from forty-six to three-hundred horse-power, and proving conclusively that the exact object sought is not to be obtained by calculation.

This variety is very convenient, for it is always possible to fit a desired power to a given gear, and if a badly designed gear should break, it is a simple matter to find a rule to prove that it was just right, and must have met with some accident.

Although no rule can be called reliable, the one that appears to be the best is that given by Box, in his Treatise on Mill Gearing. Box's rule, which is based on many actual cases, and which gives among the lowest, and therefore the safest results, is by the formula:

$$\text{Horse-power of a cast gear} = \frac{12\, c^2 f \sqrt{d\, n}}{1{,}000,}$$

in which c is the circular pitch, f is the face, d is the diameter, all in inches, and n is the number of revolutions per minute.

Example: A gear of two feet diameter, four inches face, two inches pitch, running at one hundred revolutions per minute, will transmit

$$\frac{12 \times 2 \times 2 \times 4 \times \sqrt{24 \times 100}}{1{,}000} = 9.4 \text{ h. p.}$$

For bevel gears, take the diameter and pitch at the middle of the face.

It is perfectly allowable, although it is not good practice, to depend upon the gear for from three to six times the calculated power, if it is new, well made, and runs without being subjected to sudden shocks and variations of load.

The influence of impact and continued service will be appreciated when it is considered that the gear in the example, which will carry 9.4 horse-power, will carry seventy horse-power if impact is ignored, and the ultimate strength of the metal is the only dependence.

A mortise gear, with wooden cogs, will carry as much as, or more than a rough cast-iron gear will carry, although its strength is much inferior. The elasticity of the wood allows it to spring and stand a shock that would break a more brittle tooth of much greater strength. And, for the same reason, a gear will last longer in a yielding wooden frame than it will in a rigid iron frame.

52.—HORSE-POWER OF CUT GEARS.

We know a little, and have to guess the rest, as to the power of a cast gear, but with respect to that of a cut gear we are not as well posted, for there are no experimental data upon which a reliable rule can be founded.

Admitting, as we must, that impact is the chief cause of the deterioration of the cast gear, we are at liberty to assume that a properly cut and smoothly running cut gear is much more reliable.

No definite rule is possible, but we can safely assume that a cut gear will carry at least three times as much power as can be trusted to a cast gear of the same size.

The great reliance of those who claim that a cast gear is superior to a cut gear is upon the hard scale with which the cast tooth is covered. This scale is not over one hundredth of an inch thick, is rapidly worn away, and is of no account whatever. From that point of view it is difficult to explain why a wooden tooth will outwear an iron one, although it is softer than the softest cut iron.

Assuming that a cut gear is about three times as reliable as a cast gear, we can compute its power by the formula:

$$\text{Horse-power of a cut gear} = \frac{c^2 f \sqrt{d\, n}}{30}$$

in which c is the circular pitch, f is the face, and d is the pitch diameter, all in inches, and n is the number of revolutions per minute.

The Effect of an Unbalanced Eccentric or Governor Ball on the Valve Motion of Shaft-governed Engines.

BY JOHN E. SWEET, SYRACUSE, N. Y.

(A Paper Presented at the Cincinnati Meeting of Mechanical Engineers.)

The fast-growing family of steam engine governors, known as shaft governors, can be divided into two classes. In one class, the eccentric is forced over, through the agency of some wedging action, such as a secondary eccentric or slide. In the other class, the eccentric is pulled or pushed, by the force of the governing weight direct.

The advantage of the first class is, that any resistance in the valve does not recoil on the governing weight, and hence affect it, and the disadvantage is, that the extra friction impairs its sensitiveness. The advantage in the second class is, that of possible sensitive governing, and the disadvantage of being easily disturbed by external influences.

In discussing the question some ten years ago, with the late John Coffin, as to what would be the effect on the valve motion of an engine, were the governor ball unbalanced, he said, "The ball would revolve in a circle, but the center of the circle would be below the center of the shaft."*

This seemed so reasonable that it was accepted as a fact—until the last year we labored under the delusion, notwithstanding that disturbed valve motions were occurring with disagreeable frequency. We contented ourselves by attributing the cause to every possible agency but the true one. Something like a year ago, Mr. E. J. Armstrong, of this society, had an aggravated case of valve disturbance in an engine, well suited to experimenting; and as a matter of investigation, he fixed a pencil in the eccentric and obtained the diagram, accurately reproduced in Fig. 190.

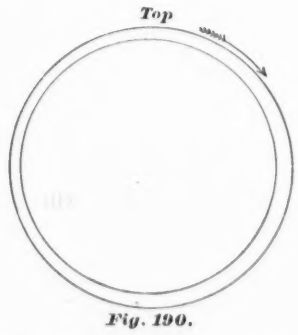


Fig. 190.

His belief that the distortion of the eccentric curve must have been caused by the unbalanced eccentrics led him to the consideration of the effect of gravity on a weight, working under the condition of an unbalanced governor ball. For the action of an unbalanced eccentric is the same in extent as a governor ball which had added to it weight enough to counterbalance the eccentric, and with the eccentric omitted.

* This is the only case of the kind where I ever knew him to be mistaken, and the last letter I ever received from him was in acknowledgment of this error.—J. E. S.

To put this problem in its most simple form, what will be the effect of gravity on an unbalanced governor weight? Assume that the ordinary fly-wheel A, Fig. 191, has arranged within it a weight B, free to move radially, and held in, against centrifugal force, by the spring C. With the spring properly proportioned to a given speed, given the proper initial tension, and the wheel maintained at that speed, the tendency of the ball to go out by centrifugal force, and the tendency of the spring to draw it in, will exactly balance each other, wheresoever the ball may be placed. So that, were it not for the disturbing influence of gravity, the ball might be set anywhere out or in, and would there stay, so long as the constant speed of the wheel was maintained. To consider what the effect of gravity would be, acting upon this weight under these conditions, assume, when the wheel is turning in the direction shown by the arrow, that the weight is at a. When the weight has reached the position b, gravity has drawn it out from the center; at c, it is farther out; at d, farther yet; at e, still farther, and so on until it arrives at g, after which, at h, it is drawn in by gravity, and so on would reach the point a, at the completion of the revolution. This curved path of the disturbed ball corresponds with the eccentric curve obtained in Armstrong's experiment; and it will be seen

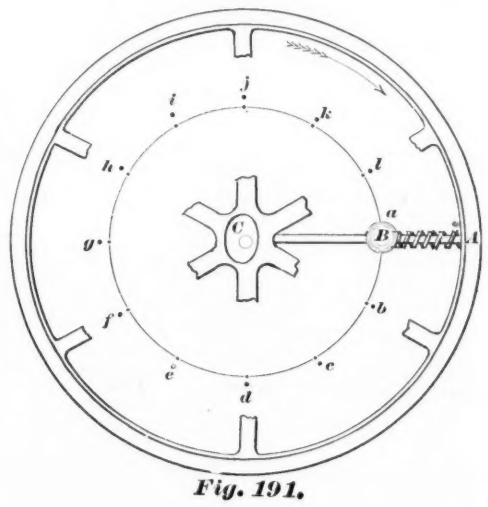


Fig. 191.

that, instead of being a circle, with its center below the center of the shaft, it is not a circle, and the center is directly at one side, in the best possible position to disturb the valve motion of a horizontal engine. It will also, by a slight reflection, be understood that the slower the speed, the greater the disturbance; because the longer the time given to gravity to act, the greater its effect.

I do not know that the discovery of this fact in regard to the revolving weight, or this method of presenting it, is here given for the first time; but if it is, Mr. Armstrong is entitled to due credit for its discovery and its elucidation.

The effect of this disturbance, caused by either an unbalanced eccentric, governor ball, or other unbalanced elements in the governing mechanism, will be better understood by reference to the small curved line C, which is parallel to the path of the ball.

"The Swinerton Locomotive."

(Communication.)

Editor American Machinist:

I am greatly obliged to you for the gratuitous advertisement of our locomotive "Onward," that appeared in so prominent a place in your issue of the 1st instant.

I shall be under further obligations to you if you will kindly inform me what "the well known laws of mechanics and of friction" are, to which you allude, and direct me where they may be found.

Since "Mechanical Engineer" follows your name in the caption of your paper, you should know where to turn to these laws without giving you much trouble. Hoping you will do me this favor, I remain,

Yours, ever truly,

C. E. SWINERTON,

Prest. Swinerton L. D. W. Co.

Stress in Structures.

PARALLELOGRAM OF FORCES.

In our issue of April 10th, page 4, we have shown experimentally the important property of the parallelogram of forces. There we suspended two equal weights from the extremities of the thread, and another heavier weight from its center. Now let us determine experimentally, and examine the result by suspending unequal weights from the ends of the thread. For this purpose we use the same apparatus as before, as will be seen by comparing Fig. 2 in the former paper with Fig. 1 in the present one. Suspend a weight of 6 pounds from the end D, and another weight of 4 pounds from the end F; also at C, somewhere about the middle of thread, attach another thread, and from it suspend a third weight of 8 pounds. After a few oscillations this system of weights will come to rest, and the threads place themselves in certain definite positions, just as they did in the previous experiment Here we have again a point C, acted on by three forces. The directions in which these forces act are of course shown by the directions of the threads, and the magnitude of the forces are represented by the weights. Now, place behind these threads a piece of paper attached to a drawing-board, and on the paper draw a line $f\ i$ parallel to thread $A\ C$, also $i\ g$ parallel to $C\ B$, and a third line parallel to $C\ G$. The tension on the thread $C\ G$ is evidently equal to 8 pounds, therefore lay off on the line $C\ G$ a distance $C\ k$ equal to eight parts from any scale of equal parts—a decimal scale should be preferred; with the same scale make $f\ i$ equal to six equal parts, because the tension on the thread $A\ C$ is evidently equal to 6 pounds; and lastly make $i\ g$ equal to 4 parts of the same scale. If, for instance, we adopt half of an inch to represent one pound, then the line $C\ k$ must be $\frac{1}{2} \times 8 = 4$ inches; the line $f\ i$, equal to $\frac{1}{2} \times 6 = 3$ inches; and the line $i\ g$ equal to $\frac{1}{2} \times 4 = 2$ inches. So far, we have represented completely on paper the three forces acting on the point C. Through the point f draw a line $f\ h$ parallel to $i\ g$; and through g draw $h\ g$ parallel to $f\ i$, meeting $f\ h$ in the point h; join the points h and i by a straight line. Here, then, we have a parallelogram $f\ h\ g\ i$, and its diagonal $h\ i$. Now let us examine the diagonal; we find—if the figure has been correcly drawn—that if the diagonal $h\ i$ is prolonged downwards it will coincide with the line $C\ k$; that is to say, the diagonal $h\ i$ and the line $C\ k$ will form one straight line. Again, measuring the diagonal $h\ i$, we find that it is exactly the same length as $C\ k$; if, for instance, the line $C\ k$ is 4 inches long, then the diagonal $h\ i$ will also be 4 inches long. Now, because $h\ i$ and $C\ k$ are equal to each other, they represent forces of equal magnitudes, and because $h\ i$ and $C\ k$ lie in the same straight line, these forces act in one straight line; but there is this difference: the force represented by the line $C\ k$ evidently acts downwards, as indicated by the arrow, and it must also be evident that the force represented by $h\ i$ acts upwards, because it is the combined effect of the two forces, $f\ i$ and $i\ g$; hence here we have two equal forces, $h\ i$ and $C\ k$, acting in opposite direction, and therefore must balance each other.

But our experiment shows us that the forces $f\ i$ and $i\ g$ also balance the force $C\ k$, hence it is plainly seen that these two forces can be replaced by the force $h\ i$. In a previous paper we have seen that a single force which will exactly replace two other forces, and produce the same effect on the point acted on as the combined effect of the two forces, is called the resultant of the two forces. Here, then, the results of our experiment again establish the important property of the parallelogram of forces previously given, namely: If two forces acting on a point be represented in magnitude and direction by the adjacent side of a parallelogram, then the resultant of the two forces will be represented in magnitude and direction by the diagonal of the parallelogram which passes through the point on which the forces act. It will be noticed in this example that the diagonal $d\ i$ does not bisect the angle $f\ i\ g$ like it did in the last example. The reason for this is plain; for the resultant of two forces will always lean more to the greater of the two forces than to the smaller one; now, since $f\ i$ is greater than $i\ g$, the resultant $i\ h$ will lean towards $f\ i$, and consequently the angle $h\ i\ f$ will be smaller than the angle $h\ i\ g$.

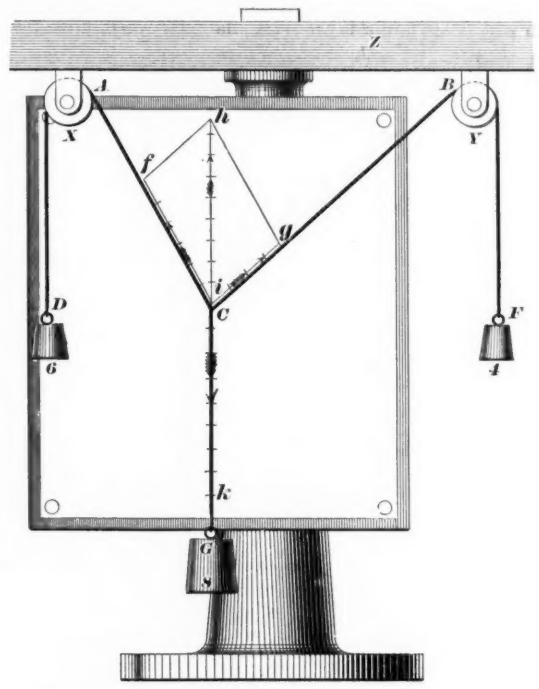


Fig. 1.

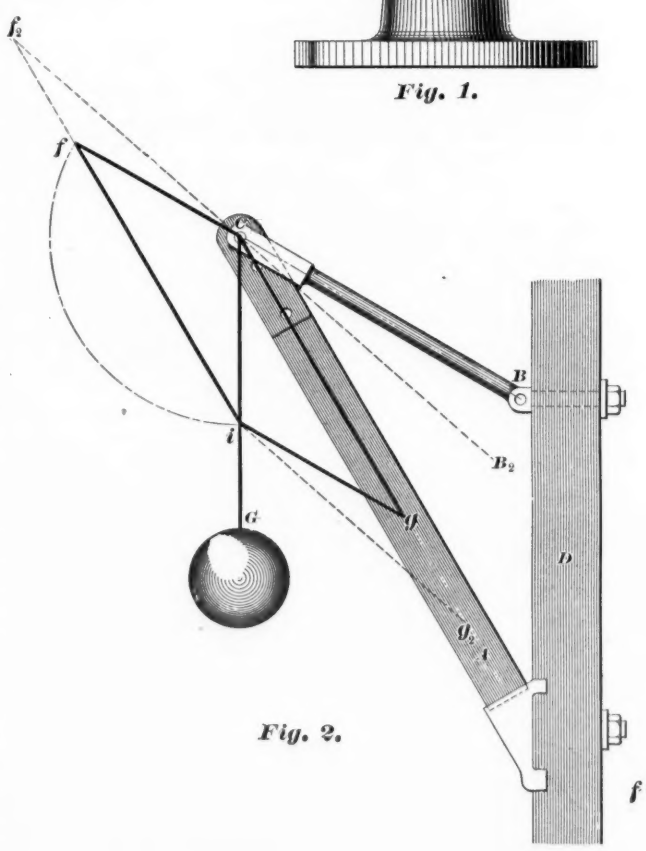


Fig. 2.

The investigation of these experiments also teaches us how we may find, by a graphical method, the direction of any two forces in a system of three forces acting on a point, the three forces being in equilibrium, the magnitude of all the forces and the direction of one of them being given. For example: There are three given forces of 6, 4 and 8 pounds acting on a point; these forces are in equilibrium; the force of 8 pounds acts downwards in a vertical direction; find the direction of the other two forces.

Assume the drawing-board to be removed from behind the threads. Draw on it a vertical line $h\ i$ (we refer here to Fig. 1), adopt some scale of equal parts to represent units of weight, for instance, adopt one inch to represent one pound; now, since the vertical force is equal to 8 pounds, make $h\ i$ 8 inches long; from h as a center, and with a radius of 4 inches, describe an arc of any length; from i as a center, and with a radius of 6 inches, describe another arc cutting the former one in the point f. Join f and h, also f and i, by straight lines; complete the parallelogram $f\ h\ g\ i$. The sides $f\ i$ and $i\ g$ of the parallelogram will now not only represent the magnitude of the two forces, but these sides also show the directions in which the forces act; these directions were to be found.

Let us proceed one step further; prolong the diagonal $h\ i$ towards k, and make $C\ k$ equal to 8 inches, so as to represent by our scale a force of 8 pounds. We have now drawn three lines, $f\ i$, $i\ g$ and $C\ k$, which completely represented the three given forces acting on the point C. To prove that the construction is correct, let us hold the drawing behind the threads from which the weights of 6, 8 and 4 pounds are suspended, as shown in the figure; we shall find that two of the sides of the parallelogram, namely, $f\ i$ and $i\ g$, will coincide with the directions of the threads $A\ C$ and $C\ B$, and the prolongation of the diagonal $h\ i$ will coincide with $C\ k$, which plainly shows that the construction is correct. If we had made the side $f\ h$ equal to 6 inches instead of 4 inches, and the side $f\ i$ equal to 4 inches instead of 6 inches, then we would have been compelled to suspend the weight of 6 pounds from the end F, and the weight of 4 pounds from the end D, before we could have made the prolongation of the diagonal $h\ i$, the sides $f\ i$ and $i\ g$ coincide with the directions of the threads. In either case the magnitude of the angles $f\ i\ h$ and $h\ i\ g$ will not be changed, and consequently the relative directions of the forces will remain the same.

This experiment again asserts the principle of the parallelogram of forces, that two forces acting on a point have a resultant; the two forces are represented in magnitude and direction by two adjacent sides of a parallelogram, and the resultant is represented in magnitude and direction by the diagonal of the parallelogram.

Here we have shown the manner of finding the direction of the forces when their magnitudes are known; but by a little reflection it will easily be seen that, if we know the directions in which three forces act on a point, and the magnitude of one of them is given, we can readily find the magnitude of the other two forces; indeed, an example of this kind we have already given in our issue of April 10.

This method of finding the magnitude of two forces in a system of three forces acting on a point, when the magnitude of one of the forces is given, as well as the directions in which all the forces act, is very useful in finding graphically the stresses in structures, as we shall now proceed to show.

Let $C\ B$ (Fig. 2) represent a tie rod, $C\ A$ a strut, and G a weight of 4,000 pounds suspended from the point C, in which the center lines of the tie rod and strut meet; it is required to find the tension on the tie rod and the compression on the strut.

Our first step will be to adopt a scale of equal parts with which the magnitude of the forces can be laid off and measured. Let us adopt a scale whose equal parts are each one-half inch, and let each part represent 1,000 pounds.

Through the point C draw a vertical line $C\ G$, and on it lay off from C a distance $C\ i$ equal to four equal parts; we say four equal parts because each part represents 1,000 pounds, and the line $C\ i$ must represent 4,000 pounds, equal to the weight G. The weight G is held by two forces acting in the direction $C\ B$ and $C\ A$; therefore prolong the center line $C\ B$ towards f; through i draw $i\ g$ parallel to $C\ B$; also through i draw $i\ f$ parallel to $C\ A$, and thus complete the parallelogram $C\ g\ i\ f$. Now the tension on the tie rod is represented by the side $C\ f$, and the compression is represented by the side $C\ g$. Measuring $C\ f$ we find it to contain four equal parts of our scale, therefore the tension on the tie rod will be $4 \times 1{,}000 = 4{,}000$ pounds, which in this case is equal to the weight G. Measuring $C\ g$ we find it to contain seven equal parts, therefore the compression on the strut will be $7 \times 1{,}000 = 7{,}000$ pounds.

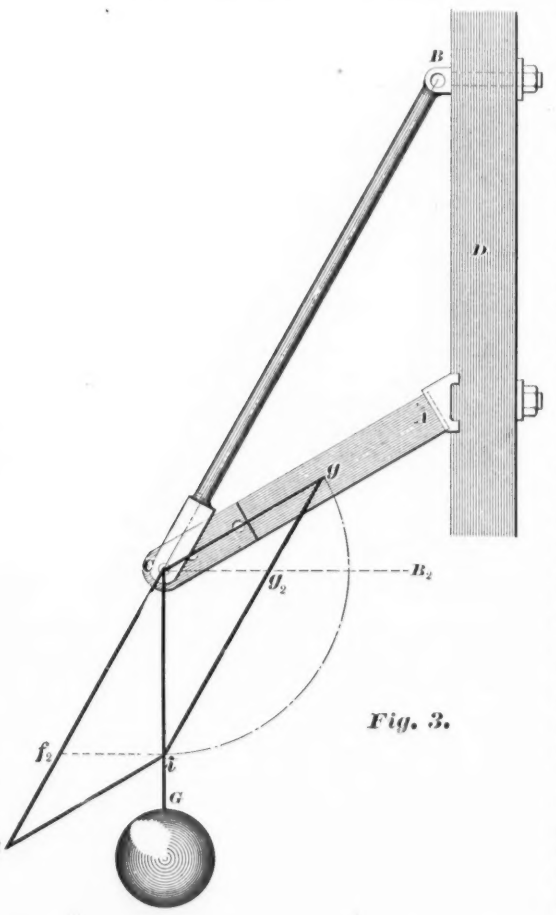


Fig. 3.

Now let us see what the effect will be by changing the position of the tie rod; say we move it so as to make its center line $C\ B$ coincide with the line $f_2\ B_2$, everything else remaining the same as before. Construct the parallelogram $C\ g_2\ i\ f_2$; the side $C\ f_2$ will now represent the tension on the tie rod, and the side $C\ g_2$ the compression on the strut. If the side $C\ f_2$ contains six equal parts, then the tension on the tie rod will be $6 \times 1{,}000 = 6{,}000$ pounds; and if the side $C\ g_2$ contains nine equal parts, we have for the compression on the strut $9 \times 1{,}000 = 9{,}000$ pounds. Here it is seen that by simply changing the position of the tie rod we have thrown upon it an increased tension, and we have also increased the compression on the strut. This fact is worthy of notice, as it teaches us that care must be taken in placing the different members of a structure, because in some positions the stress on the members of the structure is necessarily increased, and consequently an increased amount of material is required to enable the members to do their duty.

Fig. 3 shows another framework, which is the reverse of that shown in Fig. 2.

Let G be a weight of 4,000 pounds suspended from the point C, in which the center lines of the tie rod and strut intersect. It is required to find the tension on the tie rod $C\ B$, and the compression on the strut $C\ A$.

Let us again adopt the same scale as before. Draw the vertical line $C\ G$, and on it lay off the distance $C\ i$, equal to four equal parts. Prolong the center line $C\ B$ towards f, and construct the parallelo-

gram $Cf\,i\,g$, whose side $g\,i$ is parallel to Cf, and $f\,i$ parallel to Cg. Now Cg will represent the compression on the strut, and, if we find it to contain four equal parts, then the compression on the strut will be $4 \times 1{,}000 = 4{,}000$ pounds. The line Cf will represent the tension on the tie rod, and, if we find it to contain seven equal parts, then the tension on the tie rod will be $7 \times 1{,}000 = 7{,}000$ pounds.

If we move the strut in a horizontal position, as indicated by the line CB_2, leaving everything else the same as before, then we obtain the parallelogram of forces $Cg_2\,i\,f_2$. In this case the side Cg_2 represents the compression on the strut; and, since Cg_2 is much shorter than Cg, we see at once that changing the position of the strut to a horizontal one, we decrease the compression on it. We find that Cg_2 measures 2 3 parts of our scale, hence the compression will be $2.3 \times 1{,}000 = 2{,}300$ pounds.

The side Cf_2 represents the tension on the tie rod, and since Cf_2 is shorter than Cf, we see at once that the tension has also been decreased by changing the position of the strut. We find Cg_2 to measure 5.1 parts, hence the tension will be $5.1 \times 1{,}000 = 5{,}100$ pounds.

Cruiser No. 6.

Cruiser No. 6, for which sealed proposals will be received by the Navy Department up to June 10, is a twin screw steel-protected cruiser of about 5,500 tons displacement, of the following dimensions: Length on mean water line, 330 feet; breadth, extreme, 53 feet; draught of water, mean, 21 feet 6 inches; displacement on normal draught, 5,500 tons; indicated horse-power, 13,500; speed, 20 knots. The vessel is designed on the cellular system of double bottom, and the hull is to be constructed of mild steel. The protective deck is 4¼ inches thick on the slopes, and two inches on the flat over the machinery space, and three inches thick on the slopes, and two inches on the flat of deck forward and aft. The main deck is plated with 10-pounds plate, and the berth-deck plating is of 7½ pounds. Both the main and auxiliary steering gear are below the protective deck, and can be operated either by hand or steam. There are two steel masts with double military tops, the search lights being mounted in the upper tops.

A belt of woodite, thirty-three inches thick, in coffer-dams extending four feet above and four feet five inches below the load water line, extends the whole length of the vessel. Coal protection is afforded to the machinery by the location of the bunkers along the side below the protective deck and above the deck for the length of the boiler and engine space. The hull plating is increased in thickness in wake of all machine guns.

The engines are two in number, of the inverted vertical direct-action type, triple expansion, one on each shaft, the ship being propelled by two twin screws. The boilers are six in number, two single-ended and four double-ended, the larger ones having eight furnaces, and the smaller four. They are 15 feet 3 inches diameter, cylindrical, and are intended to carry 160 pounds per square inch. No boilers of this size and pressure have hitherto been built in the United States. The steel of the shells is 1 19-64 inches thick.

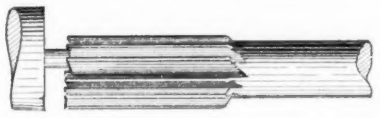
The main battery consists of two 8-inch or ten 4-inch breech-loading rifles, the latter mounted on improved pivot mounts and protected by fixed segmental shields four inches thick. The fire of all the forward and after guns, respectively, can be concentrated upon an object the length of the vessel, directly ahead or astern. The secondary battery consists of eight six-pounders, six three-pounders, and fourteen machine guns. In each of the lower military toys is mounted a 37 mm. Maxim and a one-pounder Hotchkiss. The torpedo outfit consists of six launching tubes for Howell automobile torpedoes—one fixed at the stem, one at the stern, and two training tubes on each broadside.

There is a complete incandescent electric light system, electric call bells, annunciators, mechanical telegraphs, water alarms, etc.—*The Sun.*

Shop Practice.

By Tool-room.

After cutting off stock, the next operation is to remove the tit on the ends, so the pieces can be centered. The size of the tit to be removed depends, to some extent, on the condition of the cutting-off tool, as well as the size of the piece cut off. This tit has been removed by different methods; the usual way, when there are a number of pieces, being to set a boy to work with a hammer and chisel. The chisel soon gets dull, and, instead of being cut, the projections are broken off, leaving a ragged surface for the center drill to strike on, with the result of breaking the drill, and causing the workman to use words which show a disturbed state of mind. In our works we use the Pratt & Whitney centering machine, having two spindles in a swinging head—one spindle being designed for a drill, the other for a center reamer. We dispense with the use of one spindle by using a combination drill and reamer, the advantage of which is, we secure a uniform depth of the center hole, and at the same time keep the center hole central with the countersinking. As



by this system we dispense with the use of one spindle, we were at a loss to find some use for it until our enterprising friend in the tool-room suggested that, by putting an end mill in the spare spindle, we could mill off the tits while the pieces were in position for centering, and so avoid one handling of the work, with the consequent expense; besides, the mill leaves a smooth surface in the center of the piece, which saves the drill points as well as the temper of the operative. The mill may be about ¾" diameter, with the spindle set $\frac{3}{16}$" off the center, when the end teeth will cut the projection as it advances towards the work, as shown in cut, then the other spindle is swung into position for centering. The combination drill and countersink referred to may seem like an expensive tool, but, as they are made in large lots by special tools, they can be made for what the drills alone cost. If there is a desire to know our method of making them, we would be pleased to explain for the information of those interested, but do not feel warranted in trespassing any further on your space at present.

LETTERS FROM PRACTICAL MEN.

Acceleration and Retardation.

Editor American Machinist:

On the desk in front of me, as I write, stands a little clock, which I could easily put in my vest pocket. It is as neat and handsome as a clock of its size could be expected to be, and, besides the regular hands pointing to the hour and minute, has a third one that indicates the day of the month. It is a clock which, if it had been made fifty years ago by hand processes, aided by such tools and appliances as were then in use, would have cost at least twenty-five dollars to build, and fifty dollars in the hands of the final purchaser. But my clock was not made fifty years ago, but about fifty days ago, in that stronghold of ingenuity, Connecticut, and its cost to me, including one or two profits, was one dollar.

It is a wonderful example of the cheapening influence of modern machinery and tools, and I suppose I might go on and descant upon that subject, though I don't intend to do it, but to call attention to another point.

Fifty years ago they had no such clocks, but instead they had great tall ones, which stood in the corners of hallways and rooms, and had long pendulums, which occasionally, and with the greatest deliberation and dignity, swung to one side and allowed the great weights to advance the movement a notch. Everything about the clock seemed to say: "There is no hurry; time does not fly, it drags slowly along; see how easily I keep up with it, with no apparent effort, and, in fact, without half trying." My little clock makes several beats while the old pendulum would be hesitating at the end of its swing, apparently trying to decide whether to swing again or not. And I wonder how much the general quickening of movements represented by this difference between the clocks of to-day and those of fifty years ago has had to do with bringing down the cost of clocks, and of other things as well. The sound of my clock would indicate that it is in a hurry to get somewhere, and that, unless it flies, it won't arrive on time.

We are influenced to a considerable extent by our surroundings, and I am inclined to think that the comparatively quick movement of our clocks in these days helps to make our movements quicker and make us think faster.

A machinist will often unconsciously time his movements in accordance with those of the machine he is working with. I have seen a man working on a lathe on a job requiring slow speed, and the movements of the man in putting the work into and taking it from the lathe, changing tools in the tool-post, or arranging his feed gears, would be as slow and deliberate as though that was the last job in sight and it had to last until something else came along. The next time I happen to notice this man his movements are rapid and quick, and he appears full of energy, yet he has not got a new job which "must be ready for shipment on that five o'clock train"; he is working on the same job as before, nor has any one said anything to disturb him; he has simply flipped his belt up onto the fastest speed to do a little filing and polishing on his job, and moves faster in accordance with the motion of his lathe. He is no more conscious of his rapid movements now than he was of his slower movements before.

Any one can observe this phenomenon for himself by keeping his eyes open in a machine shop for a short time, and, if he cannot do it by watching others, let him take note of his own actions occasionally.

I have had going for some time on one of my drill presses a job which is done in a jig and requires nothing better than what is known as a "drill-press hand" for doing the work. For such men, I decide the proper speed for their jobs myself, and as there was no speed on the machine just right for this particular job, I chose the slower of the two that came nearest to it. I was getting 125 pieces per day, which for a time was all I wanted. But finally the time came when I must have more, and I concluded to try the higher speed, and put up with the increased grinding and tool making, likely to result from it. Noting the time spent in actual drilling, counterboring, etc., and that spent in putting the pieces into and taking them from the jig, I figured that the increased cutting speed would give me about 140 pieces per day, and was surprised to find that the actual results were 150 per day. At first I was puzzled to account for it, but finally, on again timing the several operations, found that the time spent in placing the work in the jig and taking it out, had been reduced as well as the time of drilling. I believe the rhythmical pulsation of sound from the bevel gears just above the workman's head, being quickened, made him work faster without knowing that he did so.

The soft cluck of a loose pulley overhead, which has worn too loose for even a loose pulley, if slow and deliberate, will, I believe, have its influence in making the whole shop and everybody in it slow.

Not all men are influenced by such things, but I believe many of them are, and that the quick-beat clocks can be credited with some of our marvelously rapid progress. I am not one of those who believe so much in the great advantages of this rapid progress, so far as adding to the sum of human happiness is concerned, and I don't know that men ought to be influenced in the rate of their working, by the quick or slow moving things about them. Every one who has anything to do, should do it, I think, with that degree of energy and rapidity which he feels that he can maintain without drawing too heavily upon his vital forces. The man who works to the point of exhaustion or extreme fatigue is working harder than he ought to work, and harder than men will work in the coming time, when the real object of work and enterprise is better understood. I mention the matter, not as indicating a method of getting more work done, but simply because it is a phenomenon that has interested me, and which I suppose will interest other machinists.

T. A. Pandie.

Lathe Centers Again.

Editor American Machinist:

I think it will be well to call "Jarno's" attention to what he said when he first recommended the interchangeable lathe center, and just what he did recommend. It seems that "Jarno" either had a dream of seeing a "cabinet of curiosities" or that he saw one while awake, which put him to sleep and caused him to dream. In recommending anything new, it is always first in order that we state what the difficulties are which call for the proposed improvements, supposing that the thing in question is so obscure in the minds of most people that they do not readily see it. This is what I understand "Jarno" to mean when he told about the "cabinet of curiosities." He recommended an interchangeable system for the world to overcome this difficulty. This difficulty does not exist in shops where they know enough to keep things in their proper place.

"Jarno" thinks that I never have made any lathe spindles by "the approved plan" shown in his sketch. I have, and I never knew any spindles with taper holes, that were expected to be true, to be made in any other way. If he recommends a standard system for the convenience of making, he does not recommend anything new. Every place recognizes that it is best to keep near enough to some standard to use the tools made for the job, but this need not make things interchangeable. "Jarno" calls upon F. E. Reed, because he says that he has proven the subject, and that his lathe centers are interchangeable. A little further along in his letter he says that it would not be well for a lathe builder to say anything different. We all know that the heads of most machine shops of the present day are not real practical mechanics. They have ideas of their own, though, and these ideas machine tool builders have to agree with. I believe that "Jarno's" scheme is not to have one maker's lathe centers interchange, but to have a standard center fit any maker's lathes in the world. I believe this to be impracticable. We can govern our own affairs very well, but when we come to try to run the affairs of others by our own way we can expect to "get left."

I claim that F. E. Reed can't prove this system till he has seen it tried. I think it would be a waste of time to give a column of names of people who agree with me, and who would not be known to the readers of the American Machinist. I know that it would be good if all milling machine spindles and drill spindles had holes that were alike. I know that this is not adopted yet. It seems to me that, when they fail to grasp the thing with real merit, that they will be very slow in grasping a thing without any. The pressure on the live center is constantly shifting, and for the finest work it is absolutely necessary that it be without any vibration.

It would not be well to take any chances. "Jarno" may be one of those gentlemen who recommend grinding machines for everything, and this might be a scheme to reduce the efficiency of the lathe in order to help his favorite. If we are going to use lathes only for "roughing out," then we might do some of the work by bolting it to the grindstone shaft, and having a saw-horse for a rest, and an old-fashioned hand tool, with a long handle to reach over the shoulder. I think we are not ready for the change. There is no need of making a thing any better than it will be kept, therefore I do not agree with some, in hiring the cheapest help in a machine shop.

Somebody recommends that all those in-

terested appoint a meeting to decide on a standard taper. I believe that if this was carried out that the ones who recommended the earth as the standard of measurement, for the reason that, if the standard should be lost at any time, they could recover it, would be there and would recommend some mountain peak for a standard taper, for the same reason. I did not advance any scheme to multiply tapers; I think if "Jarno" would look over my letter a little more carefully, that he would find that I said, continue to multiply tapers. That is, to do as we have been doing. I will not advance a scheme for the benefit of a place where they will tolerate a "cabinet of curiosities," for then it would be well if everything was made like the keys of Yale locks.

I think that nine-tenths of all the good practical mechanics will agree with me, that the best fits, and the ones to be most relied upon, are those which are made by men of good judgment, and where the final fitting is done with reference to its place. This is the cheapest and most practical way of doing the finest work, when the conditions do not call for interchangeable parts.

A MECHANIC.

Grindstones and Emery Wheels.

Editor American Machinist:

My own experience in grinding machinery is not special, but probably about equal to that of most engineers. Probably, however, I may be able to give some information which will be news to some, as it was to me, when I first acquired it. In a grindstone the cutting surface is practically a continuous band of stone bent round into a circle. It has no end and no beginning, and the tendency of use is to put more or less polish upon the surface, and the cutting particles cease to cut, for they become worn flat, and lie evenly with the general surface. If the stone is "*soft*," its surface is constantly changing, and its grinding qualities remain unimpaired by polish, but what do we mean when we speak of a *soft* stone?

A soft grindstone is not one which is formed of soft material, but one which is formed of hard particles weakly cemented together. Assuming the stone to be new, the first few minutes' work, or hours' work, instead of polishing the surface, gradually loosens the surface particles, and so an entirely new surface of fresh, sharp particles is uncovered, and the stone continues to cut as it commenced. Grinders who have a stone to work with, which polishes, are obliged to hack its surface more frequently. Hacking the surface of a grindstone has the effect of dividing the long continuous band of stone into many separate surfaces, each of which has its own end, and each such free end possesses special cutting powers, and facilitates, also, that continual change of the whole surface which is so essential to rapid work.

Fig. 1 may be taken as a type of the multiple surface produced by hacking. At the edge of the hack, at *a a*, the particles are left rough and projecting, and cut sharply, and are soon broken away, and this breaking away of the surface keeps creeping back, as at *b*, until finally the whole length between hacks has disappeared, when *a* again is at the surface, and a fresh breaking away commences and travels back as before, and so the process continues until the surface again touches the bottom of the hacking, and the tendency to polish again begins.

The best grindstones are those which best renew their surfaces steadily and uniformly, and call for least hacking. In Sheffield there is a special grit used, which passes all others in these respects, but just now I cannot recall the name of the quarry.

There are many jobs of grinding to be done, which could be much better carried out on a flat-face stone than upon a cylinder, and for such work as the knives of wood planers and other rotary cutters, or paper guillotine knives, a machine was made in Sheffield, and shown to me there at work several years, again, which not only ground such knives perfectly, but also carried out the principles I have endeavored to explain of constant surface renewal and frequency of cutting edge. The machine consisted of a long bed carrying a slide, to which was attached the material to be ground.

Transversely to this bed was an iron-face plate revolving on a horizontal spindle. This face plate was divided into, I think, six or eight boxes or divisions, as in Fig. 2.

I have no special recollection of the details, but each of the chambers of the face plate had fitted and secured within it a chunk of grindstone, as shown, and which stood clear of the face plate edge about ¼ inch. These pieces of stone could not fly out, for they were held in by the rim of the plate, and this could, therefore, be revolved at a high speed, and the pieces of steel to be ground, being upon a truly sliding carriage, were traversed to and fro across the face of stone, and an absolutely true surface thereby secured. The machine was in fact an adaptation of grindstones to the formation of a tool like the face emery wheel, but it had the advantage that it was cleaner and safer than emery, for it could be copiously watered, and so did not blue articles or draw temper. There were several cutting edges, a continual surface renewal, safety from bursting, and the possibility of using small bits of stone instead of one huge cylinder, any want of homogeneity in which means bad work and possible death to the worker.

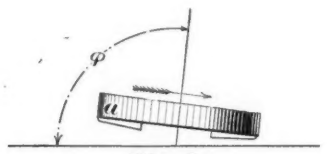


Fig. 3.

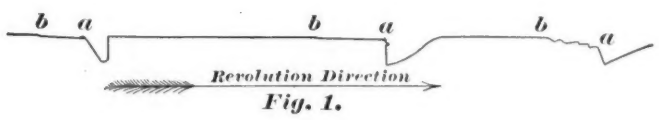


Fig. 1.

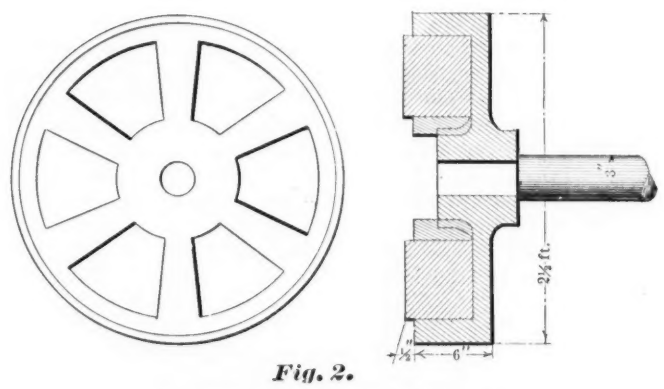


Fig. 2.

GRINDSTONES AND EMERY WHEELS.

Further, the same machine could be made to do any class of work, for a new wheel could be substituted, or the pieces of stone could be changed for those of another texture. The work done by the machine shown to me was far better and truer than that of the most skillful workman on ordinary stones.

It is several years since I saw this machine, but I well recollect the inventor of it saying that there was no reason why grinding should not, even when of the rough description, be an accurate mechanical job, as good and true as work from a planer or lathe, with the advantage, too, of a tool without spring or give. Of course, no positive accuracy can be secured in the ordinary grinding process, when a man sits on a board, one end of which presses the piece to be ground against the face of a revolving stone. The piece, of course, follows every rise and fall of surface, which is just what it should not do. If the surface be uneven, only the high parts should make contact until they wear down to the general level. Where the work follows the inequalities of the stone, the tendency is to exaggerate these until work on the stone becomes absolutely impossible. This tendency to become worse is kept in check by a good grinder, who corrects it by hacking more freely the high parts, which wear more quickly in consequence; but this is a matter of special skill, and takes time.

With the grinding machine, if not desirable to allow both sides of the face to work, so grinding both up and down, the spindle requires placing slightly at an angle with the exact transversal, as in Fig. 3. The faces of the stones are, of course, parallel with line of the bed on which the work travels, and, as the whole length of a knife being ground must pass the face of the stone, the result is equal all over. Such displacement of the spindle from the exact transverse position need only be fractional, just sufficient to keep the side *a*, Fig. 3, clear of the work. If any serious departure be made from 90° of the angle Φ, the result would be a slightly hollow face upon the article to be ground. If a hollow face is needed, it can be accurately obtained by suitable change of the angle Φ.

I think that for such emery grinders as consist in a grinding surface which is the end of a revolving cylinder, their builders might take a lesson from this sectional grindstone, which always seems to me to be an embodiment in stone of the principles of the milling machine. Fancy using a plain, smooth cylinder as a milling cutter, and yet such is the line we have been going upon for centuries in our use of stone as a cutting agent, and this, too, without any guiding principle to insure accuracy.

It is recognized in small, fine work, that absolute truth of a cylindrical surface can only be attained practically by means of some adaptation of controlled grinding, and the big machine which I have here described is simply a means of grinding controlled by exact surfaces. For truing a chilled surface and producing a plane surface on the same, nothing can touch grinding, which will tackle jobs which the hardest steel fails to perform satisfactorily, and there is no good argument against grinding when applied in its proper place and with the principles of discontinuity of the grinding surface carried out in some such way as shown in Fig. 2.

W. H. BOOTH.

Screw Cutting.

Editor American Machinist:

Reading in your paper about screw cutting, catching threads, etc., reminds me of the way I cut some screws thirty-five years ago.

The problem was to cut threads on the ends of a lot of four-inch round rods 18 feet long.

The lathe would take them in, but the lead screw lacked about three feet of reaching the end of the rods.

The swivel tool-post had a good screw in the top slide, so I turned it around parallel with the job, put in a thread tool, chalked the rod on one side, set the lathe going, seized the handle, and, with one eye on the chalk mark and the other on the handle, with a firm grip and lots of faith in muscle, I went ahead, keeping time, time, time, with a sort of spiral rhyme with the chalk mark, and when I got far enough I jerked the tool out with the cross slide screw.

Four roughing cuts, the inequalities of one being compensated somewhat by those of the next, and a little cleaning up with a "comb" made a good job. OLD MAN.

A recent fire at Scranton, Pa., destroyed property to the extent of nearly a quarter of a million of dollars. The Bloom Carriage Manufacturing Co. are large losers.

Labor Demonstrations in Europe.

To Americans the efforts that were made nearly all over Europe to suppress the May-day parades of workingmen, or to keep the paraders and those who addressed them at their stopping places within prescribed bounds, are little less than amusing.

In many parts of Europe, not battalions or divisions, but armies were massed in fear of some outbreak by the workmen.

Men were arrested before May-day by the hundred, not because they had committed any overt acts, but to intimidate the paraders, or mainly, probably, to prevent them from showing their full strength. Workmen were forbidden to parade by the authorities, and promised discharge by their employers if they absented themselves from work on that day.

On the whole, European laborers can congratulate themselves—if there is any occasion for congratulation in it—that they very thoroughly frightened the governments of Europe—England excepted—by their intention to do a little marching in favor of shorter hours of labor and better pay. In London, on the Sunday following May-day, 170,000 workmen paraded for the same purpose, and 500,000 listened to the speeches, without any hindrance and without any signs of disturbance. And in this country the workmen paraded to any extent they desired, with no occasion to think of trouble.

The custom of parading upon what are considered important occasions is probably one of the most harmless that can be indulged in. Treason is not bred in parades; it gathers its life when men are forced by the governing powers to meet in secret. Men in those European countries who were despotically deprived of their priveleges on May-day will not only hate those who deprived them, but they will teach their children to hate them.

That one hundred and seventy thousand men should parade through the streets of London, and with enough more to make a crowd of half a million, quietly listen to speeches upon subjects relating to their interests as workingmen and citizens, then as quietly disperse to their homes, must be regarded as a very significant thing, and many lessons may be learned from it. No such gathering of people could occur unless there was a very general and very firm conviction that there was important work to be done, and a determination to do it. The perfect order and discipline shown by the vast concourse was one of the most significant features of the occasion, and certainly argues well for the success of whatever may be undertaken, regardless of its merits as an undertaking.

Those who have been disposed to condemn everything done by working people, right or wrong, have been accustomed to congratulate themselves on what they supposed was the inability of workmen to unite and act in concert with a definite object in view. But there are indications that the necessity for doing this is being recognized in England and on the Continent as well, and that the best people of those countries are tired of being forced to emigrate to foreign lands to secure a fair chance in the struggle for existence, and propose to take a hand in shaping affairs so that they may remain at home. They have a right to succeed in this so long as their efforts are orderly, and carried on with a just regard for the rights of others; and, having the right to success, it is probable that they will attain it.

An exchange says:

The superintendent of a Kensington, Pa., mill ordered that girl employes shall not wear laced shoes. He say they come untied twice a day, and it takes a girl at least fifty seconds to tie them, and at that rate eighty hours each year is consumed tying shoe strings.

Something must be wrong with that superintendent's head. Probably it is too big—and empty. Flogging with the girls' shoe laces made into cat-o'-nine-tails, administered by the girls, would probably be as good treatment as he could have. It is evident that his mental condition would not admit of very harsh treatment.

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Sneering at our Navy.

A press dispatch from Berlin contains the depressing news that a German paper called the *Tageblatt* has printed an article in which our American navy is sneered at, and in which it is stated that Draconian laws and lack of proper discipline cause constant mutinies and desertions; that while the navy as a whole could easily whip some second or third rate South American republic, it would make but a poor show in a contest with a European power of equal status with the United States.

These charges, serious though they be, will be regarded by Americans with a certain degree of equanimity, not to say indifference, principally, perhaps, because they are faults some of which, at least, have been recognized by ourselves, and which we may in time hope to remedy. But there is one other charge made by our amiable German contemporary, which must, we fear, be regarded much more seriously. And this charge is, that the officers of our navy are of *inferior social rank*. Of course if this terrible charge be true there is little use in our going on appropriating millions of money for new naval vessels, in the hope of having eventually an efficient navy; for it must be perfectly evident to even the dullest comprehension that no amount of fine vessels with improved machinery and armament can ever do us the least good in a critical time, so long as these vessels must be officered by men of inferior social rank. And the worst of the matter is, we fear, that this fatal defect is the very one which we shall find ourselves powerless to remedy. If our American Congress were free to act in the matter, various titles could be conferred upon the officers we have, and thus their social rank improved; at the same time retaining what knowledge of naval warfare they may possess; but our constitution forbids the conferring of such titles, and as our naval officers are of as high social rank as anybody else in this plebeian country, we see no help for it but to take our chances, and when attacked by some power having a navy capable of fighting in an aristocratic and blue-blooded manner, defend ourselves as best we may, with shot and shell, directed by men who have been deprived of the advantages enjoyed only by those of high social rank. It is a severe blow thus to be brought face to face with a serious deficiency which we are powerless to remedy; and then to think that it should come from Germany along with her socialists, anarchists, Limburger cheese, and other afflictions, is almost more than we can bear.

English Ownership of American Industries.

A New York paper republishes an item from the London *Times*, which will not be without interest to those who have watched the course of the English syndicates in buying industrial establishments in this country, and have wondered how they could pay what seemed to be such enormous prices for them.

The item referred to gives an account of a meeting in London of the Otis Steel Co. (Limited), the syndicate which, something more than a year ago, bought out the plant and business of the Otis Steel Works at Cleveland, Ohio, issuing first mortgage bonds, preferred stock and ordinary shares to an amount far above the original capital stock of the concern. That the Englishmen knew what they were about when they thus undertook to pay interest on the bonds and dividends on the stock out of the profits of the business, is shown by the report submitted at this meeting, according to which the net profits for 1889 had been $434,594. A dividend of fifteen per cent. per annum on the ordinary shares was declared after paying all fixed charges, besides which, the sum of $227,600 was set aside for other purposes.

It seems probable that if most of the English syndicates do as well as this with the properties they have been buying up over here, there will be many more similar sales made. The greatest wonder is that Americans will sell out such establishments, even at the high prices paid, for it must be regarded as a very good investment even at two or three times the original cost. And it cannot be that these works are better managed under the English ownership, and that they can on that account afford to pay a higher price than the American owners can afford to hold them at; for the works, we understand, are under precisely the same management as they were before, the Englishmen doing nothing except to take in the profits on their investment.

There can, we think, be little doubt that this movement is an evil one for this country. It is true that this is disputed; but all the sophistry in the world cannot hide the fact that this state of affairs simply enables certain men in a foreign country to do nothing in the way of earning a living, yet to have the best of livings by simply absorbing the profits of our own labor and enterprise. It is folly to say that much of this money will come back for re-investment, and therefore there will be no serious drain upon the country; for what money comes back for re-investment will only do so that still greater amounts may be withdrawn in the shape of further profits. And it is to be remembered that these profits are not paid to the English owners of American workshops in American money—Englishmen have no use for American money—but the balance against this country will be paid in what Englishmen do have use for, *i. e.*, our food and manufactured products.

To determine whether this is a good or bad tendency, it is only necessary to consider what would be the state of affairs if a sufficient number of our industrial establishments were owned over there to make the annual profits sent to England equal to the value of what we have for exportation. We should then have the beautiful and inspiring spectacle of our industrial establishments carried on and operated by ourselves, with all the profits invested in goods produced here to be sent over to feed and clothe the people of a foreign country, they doing absolutely nothing for us in return, except, possibly, to meet once or twice a year in the London offices of the various syndicates to look over and discuss reports of the condition of the various American enterprises, and fix the amount of the profits to be divided.

Of course things will not go so far as this, but just so far as they do go they simply divert the profits of American skill and enterprise into the pockets of men who will demand and secure payment in other products of American labor and skill at prices which must compete with the world.

The Swinerton Locomotive.

We publish on another page a letter from Mr. Swinerton, brought out by an editorial in our issue of May 1st on "The Swinerton Locomotive." Mr. Swinerton is a man of intelligence, and, as we believe, is a thoroughly honest man. But as honest men before him have misled themselves, and will do so to the end of time, we believe in all honesty, and after due investigation, that he is wrong so far as the polygonal wheel is concerned. This is all the difference there is between us.

We understand, as all our readers will, that his request for a citation of authority is an attempt at sarcasm. It does not count. If we were to refer him to the laws of Morin in regard to friction—laws well known to every schoolboy, and which have never been overturned—or to the simplest laws of mechanics, one of which teaches us that it is impossible to get something for nothing, it would not avail.

Mr. Swinerton believes in the polygonal wheel; we have no faith in it, and can see no reason for such faith, either in theory or in the practical working of the wheel. We may be mistaken, but we are quite content to await the verdict of time.

One hundred and eighty-five boats left Buffalo on the day of the opening of the Erie canal, carrying 1,540,000 bushels of grain. Let some one who believes the canals are played out, figure how many ordinary freight trains would have been required to freight this grain, or what the cost of transportation by rail would have been but for the competition of the canals. The State of New York cannot afford to lose her canals—not yet, anyway. They are a check upon railroads that the country cannot afford to get along without.

Literary Notes.

The South's Redemption from Poverty to Prosperity. Most of the matter contained in this pamphlet was published in the *Manufacturers' Record* of December 21, 1889, but that issue having become exhausted it was decided to publish the matter in pamphlet form. Its aim is to present a general view of what has been accomplished by the South in the way of restoring the losses entailed by the war, and nothing is included in this which is merely projected or talked of, though in connection therewith a few statements to show what are the possibilities are given from well-known and respected authorities. As may be supposed, a very excellent showing is made, facts and figures being given regarding the development of manufactures of all kinds—railroad building, agriculture, banking, etc. The pamphlet will prove useful and interesting to those who wish to know what is being done, and what is likely to be done, in the South. It is published by The Manufacturers' Record Co., Baltimore, Md. Price, 25 cents.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(177) S. T., Chicago, Ill., writes: I wish to use small wire from 12 to 20 gauge, of great tensile strength. What can I get stronger than steel? Where can I find a table recently compiled giving the relative strength of wire from various metals and alloys? *A.*—We do not know of any kind of wire which has a greater tensile strength than steel wire; its ultimate tensile strength varies, for annealed wire, from 30 to 50 tons per square inch, and for unannealed, from 50 to 90 tons. Tables for the strength of metals and wires you will find in any of the recently published editions of engineers pocket-books.

(178) L. B., ———, asks: Will you please give me the best way to temper small springs for guns and locks, etc., so they will be likely to stand good? I have a good deal of trouble with springs, and thought I might get some help through your paper. *A.*—Not much help in a matter of this kind can be given through a paper. It is chiefly a matter of skill, which must be acquired by experience. The first thing to do, of course, is to be sure that good steel is secured. The springs you make are mostly flat springs, we suppose, and, if so, then in finishing them see that no file marks or scratches run across the springs; make them all run lengthwise. Heat them moderately and evenly for hardening, and then "blaze off" in oil from one to three or four times, *i. e.*, dip them in oil and heat over a fire until the oil takes fire and burns off.

(179) C. F. H., Boston, asks: Will you give me the diameter of a roll that, in going 31 threads on a screw that is 20 threads to the inch, will make one turn; or, in other words, make one turn in going round the screw 31 times, the screw being $\frac{58}{1000}$ inch diameter at the bottom? As I do not care about the top of threads, I do not give the size? *A.*—You have not stated all the conditions necessary to know in giving an answer; but assuming that the axis of the screw and the axis of the roll are parallel one with the other, then the diameter of roll will be $.058'' \times 31 = 1.798''$. But if the roll is a disk which goes between two threads, and is inclined to suit the angle of the spiral, then its circumference must equal the length of the helix for 31 threads. The length of this helix is 5.8574", and the diameter of the roll will be this divided by 3.1416, which gives 1.8645".

(180) J. R., Toronto, Canada, writes: In answer to Question 65 in your issue of February 13, current volume, you say that the pressure is both equal above and below the water line with water added thereto. I have always thought so, but lately several cases have come under my care which have almost changed my opinion. I am not sure if such defects as I have seen would stand the pressure in the steam space. Will you please correct or confirm my wandering ideas on this subject, as I believe the water acts as a cushion. *A.*—We cannot confirm your ideas; although water may be compressed to a very small extent, yet the amount is so small that for all practical purposes we may assume that water is incompressible, and therefore cannot act as a cushion, any more than a solid piece of iron would do. The pressure per square inch on the bottom of the boiler is equal to the pressure of the steam plus the weight of a column of water one inch square extending from the bottom of the boiler to the water level. The pressure above the water line is equal to that of the steam only; and if the boiler resists this pressure we must take this fact as evidence of the strength of the sheet, no matter what the appearance may be; yet the latter may indicate great danger.

(181) A. W., Albany, N. Y., sends us a sketch, as shown in Fig. 1, with the following description: *E* is a crank which makes 50 revolutions per minute; *B C D*, a bell crank

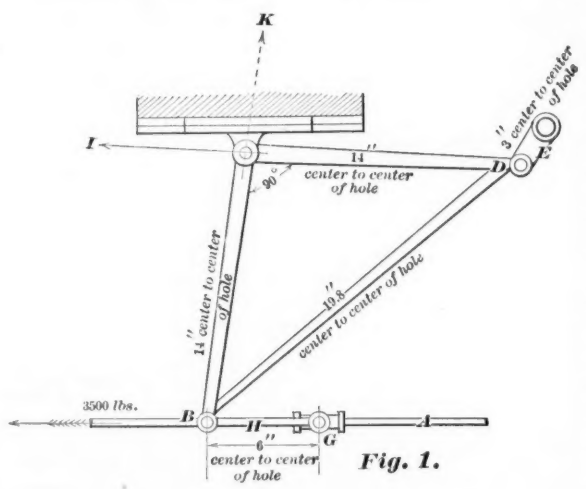


Fig. 1.

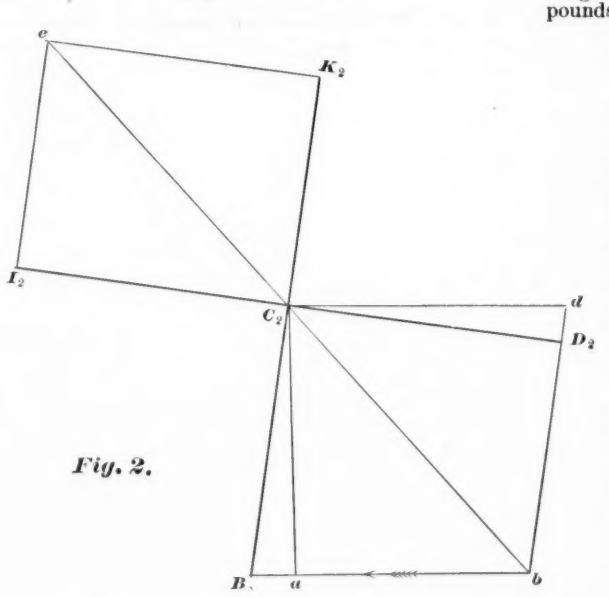


Fig. 2.

which is connected to *E;* a slide is attached to the bell crank at the center. *H*, a link connecting the bell crank to the crosshead *G; A*, a piston rod to which the crosshead is keyed. The piston rod *A* exerts a force of 3,500 pounds, and moves in the direction of the arrow. Now what I want to know is, how many pounds pressure will there be on the bolt at the center and on the crank-pin *D*, and what will be the forces acting in the directions *I* and *K*? *A.*—The required pressures and forces can be found by a graphical method, as follows: In Fig. 2 draw the lines $C_2 B_2$ and $C_2 D_2$ parallel to the center lines of the arms (Fig. 1), and on these lines lay off the lengths of the arms to any convenient scale—a decimal scale is to be preferred; through the point B_2 draw a line $B_2 b$ parallel to the action of the piston rod *A*. The lines $C_2 B_2$ and $C_2 D_2$ may be considered to be the arms of a bent lever, with a force acting in the direction $B_2 b$ on the end B_2 of the arm $C_2 B_2$. Through C_2 draw $C_2 d$ parallel to $B_2 b$, and through D_2 draw $d b$ perpendicular to $C_2 D_2$, meeting $C_2 d$ in d and $B_2 b$ in b; join C_2 and b by a straight line, also draw $C_2 a$ perpendicular to $B_2 b$. In this particular case $d b$ is parallel to $C_2 B_2$. Now $B_2 b$ represents a force of 3,500 pounds, and this force, multiplied by the length of the line $C_2 a$, gives us the moment of this force with respect to the point C_2. Considering the bent lever to be at this instant in equilibrium, the moment of the force $b d$, that is, the product of $C_2 D_2$ into $b d$, must be equal to that of $B_2 b$, which the diagram clearly shows, for it will be seen that the triangle $C_2 d b$ is equal to the triangle $C_2 B_2 b$; therefore, if $B_2 b$ represents the force exerted by the piston *A*, then $b d$ will represent the force or pressure on the crank-pin *D*. Now $B_2 b$ represents a force of 3,500 pounds, hence the force represented by $b d$ will be as much less as $b d$ is less than $B_2 b$. If we find the line $B_2 b$ to measure 14.2 units, and $b d$ 13.8 units, then the force in pounds represented by $b d$ will be

$$\frac{13.8 \times 3{,}500}{14.2} = 3{,}401.4 \text{ pounds,}$$

which is the pressure on the crank-pin *D*. The diagonal $C_2 b$ of the parallelogram $C_2 B_2 d b$ will represent the pressure on the bolt C_2, and this pressure will be as much greater than the force of the piston rod as $C_2 b$ is greater than $B_2 b$; if $C_2 b$ measures 18.4 units, we then have

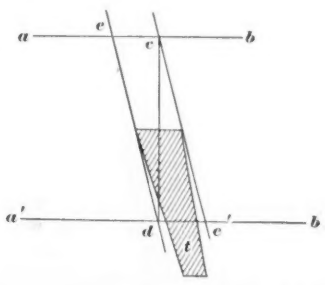
$$\frac{18.4 \times 3{,}500}{14.2} = 4{,}535.2 \text{ pounds pressure on}$$

the bolt C_2. To find the forces exerted to the directions *I* and *K* we simply prolong the lines $C_2 D_2$, $C_2 B_2$ and $C_2 b$, as shown in Fig. 2. Make $C_2 e$ equal to $C_2 b$, and complete the parallelogram $I_2 C_2 K_2 e$; the side $C_2 I_2$ will represent the force in the direction of *I*, and the side $C_2 K_2$ will represent the force in the direction *K*. In this case $C_2 e$ represents 4,535.2 pounds, and the forces represented by the lines $I_2 C_2$ and $K_2 C_2$ will be just as much less than that represented by $C_2 e$ as they are shorter than $C_2 e$. The magnitude of the required forces will change by changing the position of the bell crank, but in every case they can be found in a similar way as shown in the diagram, provided that the link *H* (Fig 1) remains in line with the piston rod *A*.

(182) R. T. T., Stamford, Ct., writes: I had to fit some brass bushings into a cast-iron box. The bushings were 3½ inches outside diameter, 2½ inches inside diameter, and 2 inches long. A 1-inch bolt was used to draw the bushings into the box, and it took two men, weighing together 380 pounds, pulling at end of a 24-inch wrench, to draw the bushing in; and when it was within a quarter of an inch of being flush we had to jerk it in. We have no steam press in our shop. Now can you inform me as to about how many pounds of steam would have been required to force the bushing into the box? *A.*—It is impossible to answer your question, since you do not state what kind of machine was used for forcing the bushing into the box. We suppose you used a bolt and nut; if so, you should have given us the pitch of thread. Even had the pitch of thread been known, we could have given only a rough approximation, since we have no means of determining the amount of force expended in jerking the end of the wrench.

(183) R. B. L., South Elgin, Ill., writes: Can you give me any information relating to the use of bronze in small castings of cast-iron? I have an old-time hand-book that recommends a small percentage of bronze for clean-cut sharp castings, and it is claimed that the metal will run in more intricate parts of the mould. If there is any other composition that will give the same results, please publish it? *A.*—We referred this question to L. C. Jewett, who replies as follows: In answering your question, I would say that I have seen some experiments made with copper mixed with iron to make a metal that would be non-corrosive, but it did not succeed. Putting tin in iron will make it more brittle; so will antimony. As to making it more fluid, the writer does not think it would be perceptible. It is claimed that fero aluminum will perform what your inquirer asks for, but I have made several experiments with fero aluminum on a small scale, and I cannot make any success of it. The best way to get good fluid iron is to use good soft brands of good quality, and not neglect to put in a good bed of fuel in the cupola, and keep it up on subsequent charges. It is my opinion that bronze mixed with iron will not work well.

(184) W. E. P., Brooklyn, asks: Will you please explain to me the rule for grinding the proper clearance of tools for cutting square threads and worms? *A.*—For ordinary cases no rule is followed for this, but a machinist learns by experience what is about right, and is usually satisfied to give *enough* clearance, and let it go at that. But where the angle of the spiral is considerable it is better to lay off the angle of the spiral at the bottom of the thread, as shown by



the accompanying diagram, in which the distance between the lines $a b$ and $a' b'$ is equal to the diameter of the screw or worm at the bottom of the threads. Connect these lines by a line drawn at right angles to them ($c d$), and from the points c and d lay off the distance $e e'$, equal to half the lead; connect these points with the points c and d by the lines $e d$ and $c e'$. The outline of the tool can then be drawn in so that its sides will have the desired clearance, as shown by the figure at t. The angles which the sides of this tool make with the line $a' b'$ will be the correct ones. In the diagram, which is made to scale and full size, it is assumed that the diameter of the screw at the bottom of the threads is one inch, and that it is to have two threads per inch single.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 16.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 140 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Castings for small and medium-sized vertical engines. Humphrey's Foundry, Bellefontaine, Ohio.

Locomotive Driving-Box Planer Tool. Pedrick & Ayer, Philadelphia, Pa.

Special Tools for Railway Repair Shops. Pedrick & Ayer, Philadelphia, Pa.

Standard Tool Co.'s Twist Drills. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Steel Name Stamps, etc. Address W. G. Sackmann, 1099 First ave., Cleveland, O.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

Well-drilling Machinery and Tools. Williams Brothers, Ithaca, N. Y.

For Pattern Letters, Steel Stamps, Burning Brands, Mach'y, Plates, &c., A. A. White & Co., Prov., R. I.

F. C. & A. E. Rowland, New Haven, Conn. Hydraulic, Mill and Special Machinery to order.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N.Y.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See May 1, p. 14. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

Patents.—Patent soliciting of high class. D. Walter Brown, 31 Nassau st., New York.

Send for "A Brief History of Patent Legislation in the United States."

25″ 28″ 32″ 36″ Upright Drills a specialty. Finely made, great capacity, quickly operated, prices low. Send for list of firms using our Drills. J. E. Snyder, Worcester, Mass.

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C. H. Redman & Co., Newark, N. J., Manufacturers of Light Machinery, Automatic Selling Machines, Telephone and Telegraph Instruments, Sewing Machine Attachments, Models, etc. Contracts solicited.

For Sale—Bound volumes of the Patent Office Gazette for years 1882, 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations. 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

Montgomery & Co., 105 Fulton st., New York City, have just issued a small catalogue of 160 pages, containing description and prices of many useful tools. A copy will be sent free to any address upon application.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

H. B. Roelker, 22 Cortlandt st., New York, late Sup't De Lamater Iron Works, will hereafter manufacture the De Lamater Screw Propeller. Propellors of same patterm and workmanship as formerly made by the De Lamater Iron Works. Each designed for its special work at lowest prices. Consulting Expert and Construction Engineer. Estimates made on machinery and on damages.

Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

MANUFACTURES

The veneer mill recently burned at Richford, Vt., is to be rebuilt.

Saw-milling is said to be the largest manufacturing interest in Georgia.

The Kerr Thread Company, Fall River, Mass., will build a mill to cost $100,000.

The large saw-mill of Charles Hebard & Son, recently burned at Pequanning, Mich., will be rebuilt.

The Macon (Ga.) Knitting Co. has commenced the erection of a two-story addition, 210x75 feet. It has a capital stock of $150,000.

A beet sugar factory is being erected at Grand Rapids, Nebraska, with a daily capacity of 400 tons. The plant will cost over $500,000.

It is rumored that a joint stock company is being organized for the purpose of erecting a gin and large cotton seed oil mill at Manor, Texas.

The East Tennessee, Virginia & Georgia is building shops and roundhouses at Knoxville, Tenn., which will cost, when completed, $600,000.

W. H. H. Slack is to remodel the Sombers building at Springfield, Vt., and put in new machinery for manufacturing shoddy under a new process.

H. C. Pease & Co., Worcester, Mass., have issued a large catalogue of improved metal planers made at the works. The cuts are well executed, and the printing and paper are fine.

The Martinsburg (W. Va.) Improvement Co. has closed a contract with B. J. Hickman, of Philadelphia, Pa., to erect a hosiery mill. A two-story building, 50x150 feet, will be erected.

John Fogg & Co., of Boston, offer to invest $100,000 in the shoe business at Dover, N. H., if citizens there will put in an equal amount. H. W. Burgett offers to put in $50,000 of the amount.

The town of Warner (N. H.) has voted to exempt from taxation for ten years the capital stock of a company that will erect a manufacturing plant in the town, with a capital of not less than $10,000.

The Falulah Paper Company will build a new mill at South Fitchburg, Mass., this year. It will be near the old mill, and the main building will be 200 by 55 feet, with an engine-room 40 by 20 feet.

The Link Belt Machinery Company, Chicago, Ill., is building a machine shop, 125x400 feet, and three stories high. They will use an electric traveling crane, and the shop will be lighted with electric lights.

The Bellingham saw-mill at Fairhaven, Wash., which has been idle ever since it was built, six years ago, will be started up by the Fairhaven Land Company, which has purchased a controlling interest in the plant.

The New Orleans (La.) Furniture Manufacturing Company, formerly the New Orleans Coffin and Furniture Manufacturing Company has doubled its capital stock for the purpose of enlarging its establishment.

The Standard Steel Casting Company have commenced the erection of large additions to their plant at Thurlow Station, Pa. The new buildings will consist of one 280x100 feet, one 100x80 feet, and one 100x60 feet.

A large car factory is shortly to be established at Mount Vernon, Ind. The buildings vacated by the removal of the Louisville & Nashville shops are to be used by the new company, which is composed of ocal capitalists.

Negotiations are in progress looking to the purchase of the San Antonio street railway by Chicago capitalists. The syndicate will also absorb the numerous rapid transit franchises granted to suburban and other companies.

There is water-works agitation at Opelika, Ala.; Atlanta, Ga.; Marysville, Ohio; Iowa Falls, Iowa; Oakland, Cal.; Meriden, Conn.; Columbus, Ohio; Denver, Col.; Boulder, Col.; Camden, N. J.; Hicksville, Ohio; Gouverneur, N. Y.

The ground has been purchased for the erection of an oil mill at Cuero, Texas. The building will be of brick, and the fixtures and machinery of the latest improved pattern. A refinery will be operated in connection with the mill.

A contract has been closed with the Railroad and Improvement Company, of Florence, Ala , to locate a large foundry for the manufacture of store fronts, architectural iron castings, etc., at that place. The plant will cost $100,000.

At Plainville, Ct., the foundation is being laid for the new shop to be built by Norton & Jones for the manufacture of patent lathes. The building is to be 66x36 feet, two stories high. The business will employ about thirty men at the start.

The Cook Railway Supply Company has been incorporated at Chicago, Ill., by B. L. Cock, G. D. Cook and A. E. McCue. The capital stock is placed at $250,000. The company proposes to manufacture and deal in patent railway supplies.

W. J. Hammond, of Pittsburgh, it is reported, will shortly erect a tinplate mill at Mansfield, Pa. The mill is to be built in connection with a steel plant which Mr. Hammond proposes to erect there. Ground has been secured for both mills.

The Chicago Aluminum Manufacturing Company was chartered at Chicago on Friday of last week, to reduce aluminum from clay and other substances. Capital stock, $1,000,000. Incorporators, M. L. Marston, Franklin Babcock, F. B. Meddock.

The people of Dexter, Maine, are working at the problem of another woolen mill. The Board of Trade have taken hold of the matter, and so far report favorably. The plan is to convert the Eldridge Bros. wood-working factory into a two-set woolen mill.

The Joseph Dixon Crucible Co., Jersey City, N. J., send us a package of crayons and pencils—black and others—made at the works. This company owns some of the most valuable graphite mines in the world, and is famous for the quality of the pencils it makes.

Efforts are being made to bring about the rebuilding of the hosiery mill burned at Meredith Village, N. H., last winter. The sum of $35,000 is required, a good part of which has already been pledged. The Hodsdon Hosiery Company offers to lease the mill at a fixed rental for ten years.

The Midland (Va.) Steel and Iron Co. has been organized, to manufacture Bessemer steel, with a capital stock of not less than $100,000 nor more than $5,000,000. The incorporators include Hon. John W. Daniel, John H. Inman, of New York City; M. M. Rogers of Roanoke, and others.

Beaudry & Co., Boston, Mass., will hereafter have their presses, power hammers and forging machinery manufactured at the Fairhaven Iron Foundry, Fairhaven, Mass. This company will attend to the manufacture and to the financial affairs of the company.

The Betts Machine Company, Wilmington, Del., have issued a catalogue of horizontal boring and drilling machines, in which the machines made by that company are described, and the advantages of such machines very clearly set forth. The catalogue is well printed and illustrated.

At the Bellaire (Ohio) Nail Works 124 nail machines are again in operation, after having been idle for about nineteen months. The blast furnace was blown in successfully last week, and a satisfactory output has been had from it ever since. The steel plant continues to be operated successfully.

The Stickney Oil Burner Company has been organized in Portland, Maine, to manufacture burners, etc. Its capital stock is $6,000, and it is officered as follows: President, H. R. Stickney; treasurer, C. R. Nelson, and directors, S. W. Bates, H. R. Stickney and C. R. Nelson, all of Portland.

The Owl Transportation Company, with a paid-up capital of $60,000, is to build wharves, docks and vessels, to operate a general passenger and freight transportation business between Bayonne, N. J., New York and Brooklyn, besides harbor towing. The shares, at $100 each, par value, have all been taken.

The Findlay (Ohio) Carbon Works have decided upon erecting a two-story iron building, 75x200. Ten kilns will also be erected, all for the purpose of engaging in their line of manufacture on a larger scale. The new factory will make carbon batteries, electrical appliances, porcelain cut-outs and incandescent lamps.

The Metropolitan Rubber Co., Wallingford, Ct., which has been carrying on its work in mills owned by the Wilson Sewing Machine Co., has just purchased the entire plant of the former owners. Considerable new machinery has been added, and it is now definitely decided that the works will have to be enlarged.

The Centralia Iron and Nail Works, of Centralia, Ill., have been standing idle for the last year. The property represents $120,000 capital, is clear of debt, has paid dividends to its stockholders to the amount of 62 per cent., and now has a cash surplus of $10,000. The company will probably put in machinery for making wire nails unless the plant is otherwise disposed of.

A Portland (Maine) dispatch says: "The plant of the Portland Company, an old and celebrated manufactory of locomotives and steam engines, has been sold to a syndicate of Portland gentlemen, composed of C. R. Milliken, W. L. Putnam, W. F. Milliken, Elias Thomas, W. T. Dunn, D. W. Kensell, C. S. Fobes and others. The price paid was par. The purchasers are to receive the May dividend."

The Pond Engineering Company, St. Louis, Mo., will furnish the Streator Electric Railway Company, Streator, Illinois, a complete steam plant, including two 125 horse-power Armington & Sims engines, Hoppes feed-water heater, pumps, pipe work, etc., erected complete. Their Kansas City office will place a 100 horse-power Armington & Sims engine in the Washington apartment house in that city.

The Pennsylvania Iron Works, Philadelphia, Pa., will build a new foundry, 100x200 feet; a section 50 feet wide, running through the center from end to end, will be occupied by an overhead traveling crane of 50 tons capacity, presenting a continuous runway for the cranes the entire length of the plant, some 500 feet. The building is to be so constructed as to enable the company to make the largest castings required in their business.

Plans for the new Paris stove foundry to be built at Leeds, near Sioux City, Iowa, have arrived, and the contracts for the foundations have been let. The structures will consist of a three-story storage warehouse, 400x75 feet; one building, 300x75 feet; a three-story building to contain the mounting and nickel-plating plant, engine and boilers, 50x200 feet, and a moulding shop, 155x350 feet. About 2,600,300 brick, and 1,500,000 feet of lumber will be used. The name of this new stove manufacturing corporation will be the Daniel Paris Stove Co.

The *Northwestern Lumberman* says: "Saw-mill men, of course, regard lath as a minor product. It is not a product so minor, however, that they do not wish they had a good deal more of it this year. In familiar language, lath are lath. All over the country there is a deficiency. Prices have advanced throughout the territory from the Atlantic coast to the Rocky Mountains. The approaching sawing season mill men will keep a sharp lookout for refuse from which lath can be made, and it is safe to make the statement that lath next year will be plentiful."

The Springfield Glue and Emery Wheel Company, in a circular letter from Bridgeport, Conn., has this to say to its patrons: "We take pleasure in announcing to our patrons and friends that we have removed our entire plant from Springfield, Mass., to this city, and are now installed in new factories, designed especially for our business, on Howard avenue and Spruce street. New machinery and the latest appliances have been added, thus affording us unequaled facilities for turning out strictly first-class goods, and to meet the constantly increasing demand for our line."

The committee appointed by the Board of Trade at a recent meeting to investigate the question of locating a paper mill at Dallas, Texas, reported to the session that the company selected a site for the mill which was donated on Cedar Creek in Oak Cliff; that the cash capital to be invested amounts to $50,000, of which $30,000 is to be invested in machinery, and the balance in buildings and raw material, and other prerequisites necessary for the operation of the mill. At the start only straw paper will be manufactured, but it is proposed to enlarge and expand the works for the manufacture ultimately of all grades and qualities of paper.

The syndicate controlling the McCarty process for manufacturing steel from the ore direct, have concluded, signed and sealed contracts for the erection of a large plant on the Steelton Company's land on the south side of the Roanoke River, about a mile west of the Salem freight depot. Railroad, merchant bar and structural iron will be manufactured first, and it is contemplated later to make heavy guns and armor plate for the navy, coast fortifications and army use. The plant will employ at least 600 men, which number will be increased to several thousand as the works are enlarged to meet the demands of business.—*Salem* (Va.) *Times-Register.*

Maxwell & Vincent have secured three acres of land in the eastern suburbs of Springfield, O., and will cover about half of it with buildings for carrying on the steel casting business, using the crucible process. They have excellent conveniences near railroads, with side-tracks running into their yards. Other locations, with the inducement of free natural gas, were offered them, but they preferred Springfield on account of its railroad facilities, its central position among manufacturing centers, and its healthfulness. They intend to be making castings before the middle of June. The Whitely Steel Works, of the same place, were erected under Mr. Maxwell's supervision.

"Advices from Hot Springs and Paris, Texas report," says the *Fort Worth Daily Gazette*, "$50,000 subscribed for the first-named place, and $70,000 at Paris, for the purpose of commencing the work of building the new road from Little Rock to Paris. The Little Rock construction committee, consisting of Zeb Ward, John D. Adams, Isaac Wolf, C. J. Lincoln, James H. Miller, John G. Fletcher, James A. Fones and J. H. McCarthy, organized to-day, Col. Ward taking $20,000 of stock, and Messrs. Adams, Wolf, Lincoln and Miller taking $5,000 each. The work is to be done by a construction company, and subscribers receive for their money unincumbered stock in this company."

Articles of incorporation have been filed with the Secretary of State by the New York Superheating Company, with offices in New York and Jersey City. The incorporators are James Gibbon, of Jersey City; C. M. Bomeister, of New York; Frederick Girken, of New York; and George Noakes, of New York. The capital stock is $250,000, divided into 2,500 shares of $100 each. The company is organized for the manufacture and sale of stoves, furnaces, grates, and other heating and lighting apparatus, and especially for the manufacture of apparatus for the generation of heat known as "Gibbon's superheating process." Articles of incorporation have also been filed by the same officers for a company to be known as Gibbon's Superheating Company, with a capital stock of $400,000, divided into 4,000 shares. The objects of this company are for the manufacture and sale of all appliances necessary for the generation of heat and light by Gibbon's superheating process.

The Nixdorff-Krein Manufacturing Company [St. Louis, Mo.] are establishing a branch factory at Copemish, Mich., a small town situated at the intersection of the Manistee & Northern and Toledo & Ann Arbor railroads, and distant from the lake ports Manistee and Frankfort only thirty miles. The location is an admirable one for a twenty-five or thirty years' supply of rock elm, a wood which the company use in the manufacture of hames, single trees, etc. Besides, the citizens of Copemish offered substantial inducements for the location of the branch, in the gift of five acres of land and a free timber-cutting privilege on a tract of several hundred acres. The factory the company are erecting will cost, when fully equipped, not far from $300,000, and will embrace all departments necessary to cutting out of the log and bending or shaping the work. The boilers and engine for the plant have already been contracted for through a Grand Rapids representative of an Ohio firm, at a cost of about $8,000, and the machinery proper will soon be purchased. Mr. Nixdorff, of the company, says the branch will greatly cheapen the cost of the wood-work in the hames turned out by the local factory, as it is much less expensive to ship the hames in a partially completed state than lumber for them bought by contract. The shipping facilities will be excellent by both rail and lake - by the latter to Chicago for re-shipment; so that he is able to see a saving running about $10 per 1,000 for lumber.—*The Age of Steel.*

On the Measurement of Durability of Lubricants.

By J. E. Denton, Hoboken, N. J.

(A Paper Presented at the Cincinnati Meeting of Mechanical Engineers.)

Practical differences of durability of lubricants depend not on any differences of inherent ability to resist being "worn out" by rubbing, but upon the rate at which they flow through and away from the bearing surfaces. The conditions which control this flow are so delicate in their influence that all attempts thus far made to measure durability of lubricants may be said to have failed to make distinctions of lubricating value having any practical significance. To illustrate: Let a standard half-inch plug-gauge and its ring be thoroughly cleansed of all oily matter by soaking in ether. If the two pieces are fitted within the limit of standard accuracy there will be, say, about one thirty-thousandth of an inch greater diameter to the ring than to the plug. The two pieces will go together with great difficulty after cleansing with ether—in general a mallet will need to be used to force the plug into the ring. But if the pieces be smeared with lard or sperm oil, or any good oil of equal fluidity, the plug may be pushed within the ring by a slight effort of the hand, and may be moved back and forth at the rate of about twenty times per minute with the utmost effort of the wrist. If the reciprocating motion is stopped for five seconds, the plug will stick, and must be driven out of the ring with a mallet. The phenomena to be here noticed are, first, that the oil allows itself to be swept into the crack between the ring and the plug by the reciprocating motion of the latter, thereby acting like a wedge to slightly expand the ring; and, second, that as soon as the motion of the plug ceases the oil between the ring and the plug is squeezed out by the elastic recovery of the ring. The orifice through which the oil flows from underneath the ring is a circular annulus one sixty-thousandth of an inch wide, and yet the flow is a perfectly definite one, inasmuch as the phenomena described repeat themselves with fair regularity.

Let both pieces be again cleansed in ether and the experiment repeated, using as the lubricant an oil so thick as to scarcely flow out of any vessel at ordinary temperature. Such an oil is found in the petroleum products prepared for steam cylinder lubrication. It will be found that the plug will enter the ring with the same readiness as when lard was the lubricant, but the force of the wrist will not be able to reciprocate the plug more than about one-third as fast, owing to the greater viscosity of the heavy oil. If the reciprocating movement of the plug is stopped, a period of at least fifteen seconds is necessary to cause the plug to stick, so that the hand cannot readily re-start it. The explanation of this difference of action of the two lubricants is simply that more time is required for the heavy oil to escape underneath the ring and allow metallic contact between the latter and the plug to be partially resumed, and that the thicker oil requires more force to overcome the friction among its own particles. The difference is proportional to the difference of viscosity as determined by the time required for each to flow through any orifice, and to their coefficient of friction as determined by any form of oil-testing apparatus capable of measuring friction with a superabundance of oil fed to the rubbing surfaces. The sticking of the plug, when it is allowed to rest, has also its parallel in the excessive friction offered by a journal to starting compared to its friction when in uniform motion, the oil squeezing out from between a journal and its brass when the former comes to rest in the same manner that it flows from underneath the ring-gauge. It is evident, however, that if these definite differences of flow of a lubricant from between two surfaces exist for such minute thicknesses of film as occur with the plug and the ring, and for such slow motion as the hand produces, in studying the action of lubricants in practice, we must adjust our observations and scale of measurement to the consideration of the most delicate and subtle forces or influences to which the lubricant can possibly be subjected in its use in practical service.

From this standpoint let us consider the results of some attempts to measure the durability of oil in the laboratory. The experiences given are those of the writer, and they are set forth in detail to an extent designed to contribute in what, it is hoped, will be a useful way to the inquiries and beliefs which are current regarding possibilities in the way of practical distinctions of lubricating value by such forms of testing machines as have thus far been used in testing laboratories. The primary idea of determining durability is, naturally, to supply a measured quantity of lubricant to certain rubbing surfaces and determine how great an amount of rubbing the lubricant will withstand before its power of maintaining the friction, at some agreed upon minimum, is exhausted. As a means of measuring the friction between two rubbing surfaces there is no device superior to what is known as the Thurston form of oil-tester, which consists in forcing a pair of brasses against a journal in opposite directions by a spring, the latter being lodged in a pendulum free to swing about the journal under the influence of the friction produced between the brasses and the latter, the amount of the fric-

tion being measured by the inclination to the vertical of a line joining the center of the journal and the center of gravity of the pendulum. Suppose one of these oil-testing machines to have a journal about 1½ inches square; then an amount of oil forming a single drop let fall from the sharp point of a steel rod, $\frac{1}{16}$ of an inch in diameter, suffices to cover the rubbing surfaces, so that with the latter in the best possible condition a very low coefficient of friction can be obtained at a rubbing speed of about 200 feet per minute and a pressure of 75 lbs. per square inch of the journal; and at the same time there will be no surplus oil—that is, all of the oil will be practically subjected to rubbing action. If, under these circumstances, we run the journal continuously until the friction, after remaining practically constant for considerable time—half an hour at least—gradually begins to increase and finally becomes double the original amount, it might easily be supposed that the number of revolutions to accomplish this would measure the durability of the lubricant used as compared to another tested in the same manner. This was, at one time, so far the belief of the writer that the relative value of oils was sought by such a test, but with the following result: The amount of oil applied to the journal was accurately gauged at 8 milligrams. The journal and brasses—the former of tool steel, hardened, and the latter of composition—were reduced to such a condition that at a given temperature a certain standard lard oil always produced a certain amount of friction, and a trial of this standard lard always preceded the trial of any other oils whose durability was to be determined relatively to the lard.* If the friction with the standard lard was too great, the cause of it was always found ascribable to incipient roughening of the surfaces, and the latter were nursed by rubbing with an oil-stone under a magnifying glass and by continued running with an unlimited amount of lubricant, until the standard condition was regained. When the oil was fresh upon the bearing surfaces it was translucent in appearance and slippery to the touch. After about 10,000 revolutions the friction might have increased to double the minimum amount, as described above, but the appearance of the oil would show no signs of deterioration; and it was found that the cause of the extra friction was the uneven distribution of the oil over the rubbing surfaces. There being no continuous supply, the oil distributed itself more or less evenly simply by chance, and a small filament or part of the rubbing surfaces could be seen to be devoid of oil. Accordingly the oil was redistributed with the pointed end of a match and the pressure reapplied, with the result that the friction at once resumed the minimum value, showing that the oil was in no sense worn out. The machine would therefore be run on until the friction again doubled itself, when another examination might still show the cause to be irregular distribution. This was again remedied and the machine continued in operation under the same programme, until finally, after several redistributions of the oil, the latter had lost its translucent appearance and oily nature, having become a dark-colored paste.

The friction would then refuse to decrease by redistribution. The total number of revolutions might be 12,000 to accomplish this result with lard oil on a given date, and the same number of revolutions might be nearly obtained on a second trial. In fact, so far did duplicate trials of the same oil apparently give the same revolutions within a small per cent., that, as stated above, the relative durability was thought to have been determined by this method with reference to lard oil. But, upon a more extensive trial of the lard, 30,000 revolutions were required to reduce it to the gummy state, and again, 60,000 revolutions, and upon one occasion 400,000 revolutions; and in between these figures would occur records of 10,000, 7,000, and as low as 5,000 turns of the machine, which, with no variation of pressure, temperature, speed, atmosphere, amount of oil or quality of the latter, were the apparent measure of the durability of this standard oil, as measured on this basis. Evidently some cause was at work which rendered the method valueless. Such cause was discovered and communicated to the writer by Dr. Charles B. Dudley, of Altoona, who had carried out similar investigations. Upon analyzing the black paste to which the lubricant reduced itself, Dr. Dudley found that it was composed mainly of the material of the bearings themselves, showing thereby that the limit to the friction-producing qualities of a lubricant tested in this manner was the rate at which it adulterated itself with the metal worn off the bearings, notwithstanding that the amount of the latter was so infinitesimal that years of operation of the machine would not detect the wear by any finite measurement of the dimensions of the bearings. The rate of this metallic wear being infinitely variable, it is evident that the durability of oil cannot be measured by restricting our measurement to the behavior of a fixed quantity whose amount shall be so small as to allow of no surplus oil about the bearings, or, in other words, maintain all of the oil under rubbing action at once. The failure of the method is attributable also to the fact that so little oil was employed compared to the amount of rubbing surface, that the latter could not remain uniformly covered. It is natural, therefore, to inquire whether the method would not be more successful if a greater amount of oil could be used permitting a slight surplus, but applied upon some plan which would enable the surplus to be employed to secure regularity in the distribution of the oil over the rubbing surfaces. Such a plan has been tried by the writer on a larger size of Thurston testing machine having a journal about four inches diameter and seven inches long, with brasses of the same proportions as used in railroad car service, except that the arc of contact was reduced, so that the total bearing area of two brasses was about seventeen square inches. The journal was of wrought-iron reduced to such a condition that, with standard lard oil under 350 pounds per square inch pressure, and about 250 revolutions per minute, a coefficient of friction of four-tenths of one per cent. could be maintained. Oil was fed to the journal through two oil cups fastened into holes in the upper brass, as shown at *L L* in Fig. 154, which shows a longitudinal section of the testing journal. After cleaning the bearing surfaces, 10 minims of oil were smeared upon them, and the pendulum hung in place. Twenty-five minims of oil were then evenly distributed between the two oil cups, while about 100 lbs. pressure was upon the bearings and the machine in motion. The pressure was then gradually increased to 350 lbs., and the machine run until the minimum friction doubled itself. Before relating the results we will consider the difference in the amount of oil applied compared to that used in the eight-milligram test, with the journal about one and one-half inches diameter. For the latter conditions each 10,000 revolutions cause a number of square inches of surface to be rubbed over, which correspond to the use of one milligram of oil for each 7,000 square inches. In the case of the larger journal 35 minims of oil correspond to the use of one milligram to each 2,000 square inches of surface rubbed over, if the 35 minims should permit 10,000 revolutions before the friction was doubled. Consequently, a considerable surplus of oil would be present in the case of the large journal, provided it could be prevented from wasting. To prevent such waste was, however, a matter of some study.

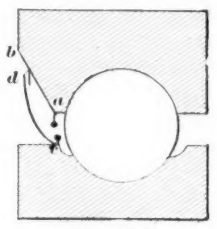


Fig. 155.

Fig. 154.

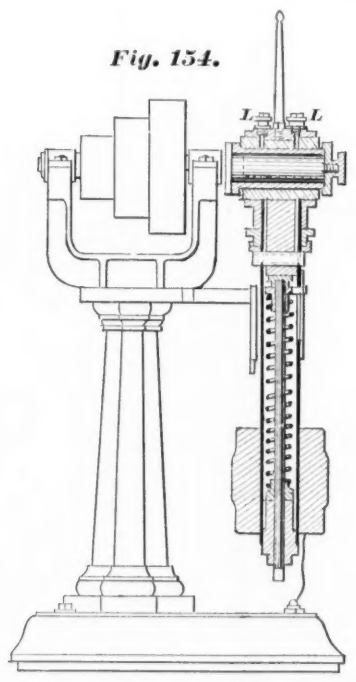
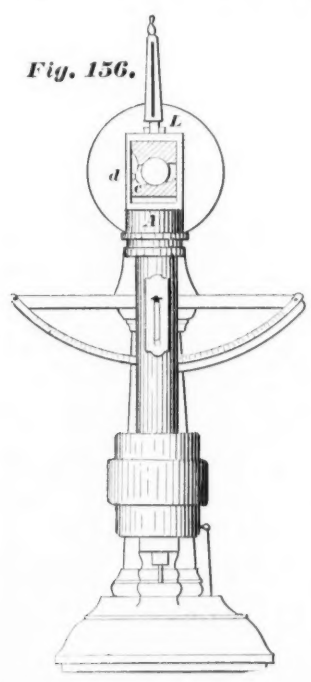


Fig. 156.



DURABILITY OF LUBRICANTS.

The 25 minims placed in the oil-cups filled the lower portions of the latter for a depth of about one inch, and flowed out very gradually, but still with sufficient abundance to cause large drops of oil to roll off the rising side of the journal as they approached the edge of the upper brass. Oil adhering to this edge of the brass was carried by capillary action, and the slight irritation of the upper brass in its framework, up the vertical sides of the latter, and gradually the entire interior of the framework enclosing the brasses was covered with the surplus oil. To overcome this irregularity the upper brass was cut to the form shown in Fig. 155, so that oil which was carried upward by the journal to the edge of the brass *a* could not climb along the bevel surface *a b*, but dropped off the upper brass to the lower brass. A flexible metal guide *c d* was fastened to the lower brass (Figs. 155 and 156) so that the oil thus dropping from the upper brass was prevented from striking the sides of the framework, but was instead caused to fall against the journal and be repeatedly drawn upward, thus assisting to maintain in a uniform condition the film of oil on the journal. The brasses were one inch shorter than the journal, so that a liberal amount of lateral motion* could be given to the pendulum. The edges of the brasses were chamfered, so that the result of the lateral movement was to accumulate a band of oil around each end of the journal, distant from the latter equal to the radius of the fillet. This band of oil absorbed a considerable proportion of the total 35 minims during the early stages of a test, but did not seem to consume oil or withdraw it from action between the surfaces after such time. To all appearances the journal was in a uniform condition of lubrication, the friction remaining perfectly constant for several hours, and the temperature remaining, with all oils of about the fluidity of lard, within 5° of 130° Fahrenheit. Yet, in spite of every precaution, successive records of lard oil were as follows:

July 9.....82,000 revs.
" 10.....67,800 "
" 13.....53,000 "
" 15.....29,000 "

and of a pure mineral oil of about the same fluidity as lard:

July 10.....36,000 revs.
Second test.....33,000 "
Third test.....27,000 "

The last three results were well calculated to lure an experimenter into the belief that the method gave duplicate results, but on continuing the test of the same oil on July 15, the record of one test was 10,600 revolutions, and of a second test 64,000 revolutions, with the friction and temperature and speed as identical as it is possible to have them. It was evident, therefore, that irregularity of conditions existed, of a nature beyond the reach of any available means of control, and, so far as is known to the writer, there is no method of employing so little oil on a journal as to prevent its escape from the latter and determining anything representative of the quality of durability. The clever device adopted in the Pennsylvania laboratory, at Altoona, of saturating a strip of felt laid in a cavity in the lower brass with the oil to be tested, is another method of making a fixed quantity of oil be wholly devoted to the lubrication of the bearing surfaces, the slight tendency of the oil to escape being checked by sucking up the waste oil with a pipette, and continuously restoring it to the journal. No attempt is made, however, to determine any quality of the lubricants tested other than their coefficient of friction. The rates at which oils are supplied to practical bearings are, however, greatly in excess of the amount applied in the above tests. Taking the average revolutions which caused the friction to double at 30,000, the 35 minims supply to a journal four inches diameter and six inches long amounts to one seven-hundredth of a milligram per square inch of surface rubbed over.

A very economical case of practical oil consumption is when a locomotive main crank-pin consumes about six cubic inches of oil in a thousand miles of service. This is equivalent to a consumption of one milligram to seventy square inches of surface rubbed over, or ten times as great an amount as that used on the testing machine. If, therefore, the latter amount provided a surplus requiring special provision to prevent escape of oil from the bearings, what must become of the surplus present on the locomotive crank-pin and other bearings using oil with the same economy, of which there are numerous examples in every class of machinery? Undoubtedly it must continuously escape from the journal. The thirty-five minims of oil, used in the test described, was so little contaminated by the absorption of metallic wear under 30,000 revolutions that the fluidity was not greatly reduced. Consequently, with ten times as great an amount of oil to absorb the metallic particles, the oil leaving the locomotive crank-pin is but little changed in fluidity, and flows from between

*A question often asked is whether measurements on an oil-testing machine can be made to duplicate themselves. In the matter of *friction* an entirely satisfactory duplication of action is always possible. For example, the following is a series of fifteen consecutive tests of different oils, and between each pair of tests the journal of the oil-tester was tried with the standard oil, and gave results as follows:

No. of Trial.				Temperature of Bearings.	Friction of Standard Oil.
1st Trial, Dec.	15th	Oil	A.	95°	1.9 lbs.
2d " "	18th			95°	1.9 "
3d " "	25th			110°	1.7 "
1st " "	15th	"	B.	95°	1.9 "
2d " "	27th			110°	1.7 "
1st " "	16th	"	C.	95°	1.9 "
2d " "	22d			95°	1.9 "
1st " "	15th	"	D.	95°	1.9 "
2d " "	18th			110°	1.7 "
1st " "	18th	"	E.	110°	1.7 "
2d " "	23d			110°	1.8 "
1st " "	18th	"	F.	110°	1.7 "
2d " "	18th			110°	1.7 "
1st " "	18th	"	G.	110°	1.7 "
2d " "	28th			110°	1.7 "

Total pressure on journal, 300 lbs.

* Whenever this lateral motion was stopped, the friction rapidly increased.

the surfaces with practically the same freedom as when in a fresh condition. It follows, therefore, that the economy of one oil over another, so far as the quantity used is concerned—that is, so far as durability is concerned—is simply proportional to the rate at which it can insinuate itself into and flow out of minute orifices or cracks. Oils will differ in their ability to do this, first, in proportion to their viscosity, and, second, in proportion to the capillary properties which they may possess by virtue of the particular ingredients used in their composition. Where the thickness of film between rubbing surfaces must be so great that large amounts of oil pass through bearings in a given time, and the surroundings are such as to permit oil to be fed at high temperatures or applied by a method not requiring a perfect fluidity, it is probable that the least amount of oil will be used when the viscosity is as great as in the petroleum cylinder stocks. This was pointed out by the writer in a former paper presented to the Society in connection with a description of various viscosimeters. When, however, the oil must flow freely at ordinary temperatures and the feed of oil is restricted, as in the case of crank-pin bearings, it is not practicable to feed such heavy oils in a satisfactory manner. Oils of less viscosity or of a fluidity approximating to lard oil must then be used, and the differences among such oils, with respect to the quality of entering and leaving the spaces between the bearing surfaces, may readily be imagined to depend in a considerable degree upon differences of capillary property arising from choice of ingredients forming any particular mixture. We are led, therefore, to conclude that a test of durability must be a test of the rate at which two oils fed to the same journal, by the same device, and under the same circumstances, permit themselves to flow between the bearing surfaces and out of, and off of, the bearings, and that oil may differ in this respect with every variation of ingredient and viscosity. As necessarily there will be surplus oil which will escape from the reservoir and do no lubricating service before being led off of the bearings, it follows that every particular condition of bearings will affect the amount of oil consumed, and hence our oil-testing machine, to determine durability, must be the very machine upon which the oil is used or a copy of the same.

To illustrate what would happen if this idea of testing durability was carried out with the large-sized Thurston testing machine referred to above, experiments were made feeding oil to the two oil cups in 50 minim doses under the same conditions as described above, except that the brasses were exactly like railroad car brasses, no provision being made to prevent the oil escaping in whatever direction it chose to flow. The machine was run until the friction began to increase above a minimum, and then another dose of 45 minims of oil was added to the cups without stopping or disturbing the machine. The oil was so regularly led away by the various escaping surfaces formed by the brasses, that in a series of about a dozen trials of lard oil versus sperm oil the latter averaged 11,000 revolutions in doubling the friction, and the lard 9,000 revolutions, with a variation of only about 20 per cent. from these figures in the various separate trials. But upon changing the brasses to another pendulum-head or framework, in which they fitted to all appearances with precisely the same degree of accuracy, a series of trials with lard oil averaged 14,000 revolutions to consume 50 minims. The slight difference in the fitting of the brasses in the pendulum-head by altering the effect of the various escaping surfaces increased the time necessary for the oil to escape. It seems hardly possible, therefore, that the quality of durability in lubricants can be measured, except by copying in a very perfect manner the exact conditions of arrangement, proportion and method of feeding which are to be used where the lubricant is to be applied; and even when this precaution is taken, the fact that in some kinds of service the limit to the consumption of oil depends upon the extent to which dust or other refuse becomes mixed with it, as in railroad car lubrication, and in the case of agricultural machinery, makes it almost hopeless to expect that laboratory tests can contribute very much of practical value in the determination of relative durability of lubricants.

That machines may be devised for the laboratory, however, and are, in fact, in use to-day in some of the latter, which will contribute much valuable knowledge to many questions of lubrication, through measurements of friction and metallic wear, is not to be denied, but the discussion of this part of the subject is not intended to be included in the scope of this paper.

A Disastrous Fire.

One of the most serious fires which has occurred in this vicinity for some time took place on the night of the 6th, at Elizabethport, N. J., and which destroyed the main building of the Singer Mfg. Co's. works, entailing a loss of near a million dollars. It is thought to have been a case of spontaneous combustion starting in greasy waste, a good deal of which is said to have been in one of the departments. About 3,700 hands were employed in the works, the capacity of which is 1,500 sewing machines per day. The buildings were erected in 1873, when the factory was removed from this city to get more room and better shipping facilities. The portion burned was four stories high, with mansard roof and clock tower, the other buildings not burned being mostly one story in height. The stock, needle, finishing, adjusting, inspection and milling rooms were in the burned portion, as was also the pattern department. The needle department is said to have been very complete, and to have cost in special machinery, etc., $250,000. Small parts for 35,000 machines were lost, and 18,000,000 finished needles. We understand that no insurance was carried by the company, but that dependence was placed chiefly upon a fire protection system within the factory, which, however, seems not to have been very effective, in view of the rapidity with which the fire spread through the building.

Most if not all of the walls of the burned building will have to be rebuilt, which, we are informed, will be done as fast as possible. In view of what is now considered good practice in shop construction, it is not likely that a mansard roof will be put on the new building, as such roofs have been declared by competent authorities to be especially favorable to fires, while they certainly add nothing to the architectural appearance of such buildings as the Singer shops.

James Nasmyth.

James Nasmyth, one of the old-time English engineers, died recently in his eighty-second year. Mr. Nasmyth is mainly known by his invention of the steam hammer, although this was by no means his only achievement. He was a graduate of the celebrated firm of Maudsley & Field, London. He retired from active business while comparatively young, and since then has followed his own inclinations, which have led him into the fields of astronomy, and in directions where other considerations than profit ruled.

A correspondent writes us that, considering the low cost of aluminum it should be urged upon the government to supply one or two of the new cruisers with aluminum propellers. He thinks the reduction in weight would be of great advantage. Doubtless it would, but we do not think that pure aluminum would be good material for a propeller wheel. Aluminum bronze, which is coming into quite general use, is about as heavy as iron.

Machinists' Supplies and Iron.

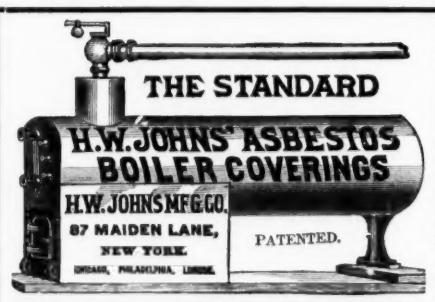
NEW YORK, May 10, 1890.

Iron—American Pig.—Consumers continue to buy in a hand-to-mouth way, only covering their immediate necessities. Offerings of Southern irons continue liberal, and the competition of Southern producers is still the main disturbing element. The approach of the first of June, when the subject of

BRADLEY HAMMERS AND FORGES.
The BEST HAMMERS in the WORLD RUN BY BELT.
Over 1500 In Use.
Three Styles, 15 lb. to 500 lb. Heads.
Our FORGES heat irons fast enough to keep Hammers and men fully employed.
Send for Catalogue and Prices.
BRADLEY & COMPANY, Syracuse, N. Y.
14 Warren St., NEW YORK. 98 Sudbury St., BOSTON.

JOHN WILEY & SONS, NEW YORK, Publish:
Wilson's Steam Boilers, 12mo, cloth, - - $2.50
Thurston's Manual of Steam Boilers, 8vo, cloth, 6.00
Ford's Boiler Making, 18mo, cloth, - - - 1.00
Thurston's Steam Boiler Explosions, 12mo, cloth, 1.50
Grimshaw Steam Engine Catechism, 18mo cloth, 1.00
" " " Vol. II, 18mo, cloth, 1.00
Whitham Steam Engine Design, 8vo, cloth, - 6.00
Hemenway's Indicator Practice, 12mo cloth, 2.00
Pray's Twenty Years With Indicator, 8vo, cloth, new edition, 2.50
Thurston's Engine and Boiler Trials, - - 5.00

THE FOX PATENT UNIVERSAL TRIMMER
OVER 2200 IN USE.
ORIGINAL — IMPROVED
Saves Time, Saves Money.
Three Sizes, From New Patterns.
NO PATTERN ROOM COMPLETE WITHOUT THEM
Send for circular. Mention this paper.
THE FOX MACHINE CO., GRAND RAPIDS, MICH.



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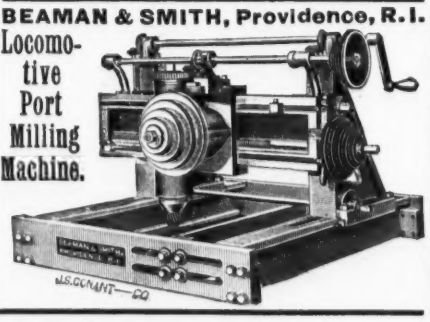
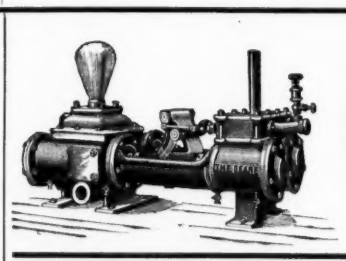
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.,
87 Maiden Lane, NEW YORK.

BEAMAN & SMITH, Providence, R.I.
Locomotive Port Milling Machine.
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STEAM PUMPS
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BEST STEEL
For Taps, Dies, Punches, Milling Cutters, Lathe and Planer Tools, Cold Chisels, Edged Tools and Hardware of all kinds.
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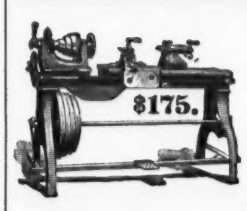

Improved Screw Cutting Foot and Power LATHES
Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.
THE SEBASTIAN-MAY CO., 167 W. 2d St.,
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TOBIN BRONZE
Tensile Strength upwards of 79,000 lbs. per sq. in.
Torsional Strength equal to the best Machinery Steel.
Anti-Frictional and Non-Corrosive.
CAN BE FORCED HOT.
Rods for pumps and bolts. Yacht shafting. Rolled sheets and plates for pump linings and condenser tube sheets, &c. Ingot metal for car and engine bearings. Spring wire.
ANSONIA BRASS & COPPER CO.,
Sole Manufacturers.
Send for Circular. CHICAGO. NEW YORK.

IMPROVED PUMPING MACHINERY | For Every Class of Work | Send for New Illustrated CATALOGUE.

BETTS MACHINE CO., WILMINGTON, DEL.
MAKERS OF
METAL-WORKING MACHINE TOOLS
FOR
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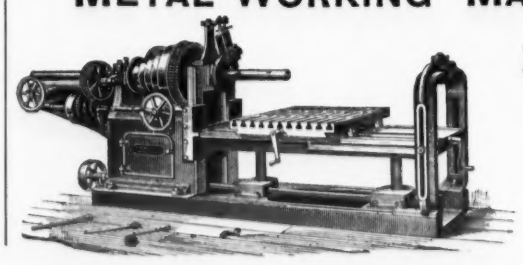
Railroad, Car & Machine Shops
AND
Iron and Steel Works
Generally.


wages will again come under consideration, is looked forward to with some interest, especially in view of the recent agitation and success of the men in some branches of skilled labor.

We quote Northern brands No. 1 Foundry, $18 to $19; No. 2, $17 to $18. Southern brands No. 1, $16.50 to $17; No. 2, $16 to $16.25.

Scotch Pig—There has been a moderate retail demand.

We quote Eglinton, $18.50 to $19; Dalmellington, $21.25 to $21.50; Coltness, $24.50 to $25.

Bar—The demand has been moderate, with prices in buyers' favor.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2, for round lots on dock.

Copper—The market has ruled firm, with a tendency of prices to go higher. The production of the lake companies is contracted ahead, while the old syndicate stock is locked up for the present by litigation.

We quote Ingot, Cakes and Wire Bars at 14⅜c. to 14½c. Common casting brands are somewhat easier, at 12¾c. to 12½c.

Lead—There has been no improvement in the demand, consumers buying only to cover immediate wants, but supplies are firmly held at prices quoted last week, viz.:

For prompt and near delivery prices are 4.02½c. to 4.05c. For future deliveries prices have ruled somewhat higher on the exchange.

Spelter—There has been some improvement in the market caused by a somewhat better demand.

We quote Ordinary brands of Western, 5.10c. to 5.25c.; Choice, 5.3⅛c. to 5.40c.; Refined, 6¾c. to 7c.; Silesian, 6¾c. to 6¾c.

Tin—Values have undergone little change until the latter part of the week, when they advanced in sympathy with a rise in London quotations. In jobbing lots prices are 21¼c. to 21⅜c.

Antimony—The demand has been moderately active, but there has been little or no change in prices for Regulus.

We quote Hallett's, 18½c.; Cookson's, 25c.

Lard Oil—No change of importance has taken place, and prices are 58c. to 58½c.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—Two first-class instrument makers. Apply by letter to T. C. Mendenhall, Superintendent U. S. Coast and Geodetic Survey, Washington, D. C.

Wanted—Good general machinist to work on Corliss engines, ice and refrigerating machinery. Address Frick Company, Waynesboro, Franklin Co., Pa.

Wanted—A first-class die maker used to tin work. Address The Norton Can Company, 284 Pearl st., New York.

Malleable iron foreman is open for engagement; understands mixing and melting. General jobbing shop preferred. X, AMERICAN MACHINIST.

Wanted—Situation as foreman by practical machinist thoroughly experienced on engine and gen'l machine work. Address "D," AM. MACHINIST.

Wanted—Position as ass't draftsman on steam engine work. Technical education abroad; some exp. in this country. Address C. W., AM. MACHINIST.

Practical draftsman and machinist, 25, technical education, familiar with blue printing and pattern making, wants position. M. P., AM. MACHINIST.

A competent mech. engineer wants a responsible and permanent position where very varied exp., especially in heavy machinery and in structural iron work, can be utilized. Box 841, Pittsburgh, Pa.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Machinists Wanted—First-class hands, competent to undertake the erection of machine tools. Steady work and good wages to good men. Betts Machine Co., Wilmington, Del.

Draftsmen Wanted—Several draftsmen that are familiar with blast furnace and rolling mill works. Give references and terms. Address Gordon, Stroebel & Laureau, L'd, Philadelphia, Pa.

Wanted—Foreman for machine shop in large city in Wis., employing about 100 men. One posted on Corliss engines and ice machines, and who understands German, preferred. S. A., AM. MACHINIST.

Foundry foreman with plenty of experience in making engine castings is wanted by a firm that will give a good position with a good salary to the right man. Address Engine Builders, AMERICAN MACHINIST.

Tool maker and machinist, with long experience on all kinds of work, wants a position where skill, experience and ability to handle men are required. References. Address "Machinist," P. O. Box, 1592, Philadelphia, Pa.

Draftsman and good vise hand, graduate at a technical school in Germany, wants position, on general machinery preferred. If there is not enough to draw, will work in the shop. Address Box 13, AMERICAN MACHINIST.

Wanted—Competent mech. draftsman familiar with punching mach'y and mach. tools. One who has some faculties for sup't will have a good chance for advance. State exp., and salary wanted. Must work himself up. W. Frech Machine Works, Streator, Ill.

Wanted—10 or 12 good machinists, principally vise hands. Only those familiar with the erecting of wood-working machinery need apply. This will be a good opening for ambitious young men. Address E. & B. Holmes, 59 Chicago st., Buffalo, N. Y.

Wanted—Machinists. Several first-class vise and lathe hands to work on punching machinery and machine tools. Steady job and good pay to first-class mechanics. W. Frech Machine Works, Streator, Ill.

Wanted—In one of the Middle States, a thoroughly competent designer on light machine tools and automatic machinery. Must be familiar with modern methods and shop practice. State positions held formerly, and give references. Address BOX 7, AMERICAN MACHINIST.

Wanted—Position as sup't or foreman by a young man, 35, successful in the systematic manufacture of machinery and mechanical devices, and in the economical management of men. A draftsman and designer of automatic and interchangeable machinery, tools, jigs, etc. BOX 14, AMERICAN MACHINIST.

Wanted—First-class turner for accurate work in tool-room. Wages, 42s. per week of fifty-four hours, with prospect of advance to a really capable man. None but first-class men with good references need apply. J. C. Peache, Messrs. Willans & Robinson, Engine Builders, Thames Ditton, Surrey, England.

Wanted—1 first-class draftsman, 3 first-class pattern makers, 15 first-class machinists experienced on engine work, and 15 first-class moulders. No second-rate men wanted, as we manufacture only high-grade work. Good wages and steady work to the right men. Address Sioux City Engine Works, Sioux City, Iowa.

Wanted—A live man for sup't. Must be a practical machinist; one who knows how work should be done, and can manage men and machines successfully on piece-work basis. Work—agricultural engines and machines, and general work. State age, experience, and salary expected. Address Box C. Schenectady, N. Y.

A Shop Foreman—A foundry and machine shop employing about 200 men, located within 50 miles of Boston, is in need of a machine shop foreman who knows how to obtain first-class work from men and tools in the fewest possible hours. A man with some experience in printing presses preferred. Address "Webster," care AMERICAN MACHINIST.

Wanted—A foreman for the machine shop of a large iron works manufacturing screwing machines, pipe taps and dies, steam fittings, and doing a general gas works business. An excellent opportunity is offered to an active man, with plenty of snap and system, and having experience in these lines. State age, experience, and pay expected. Address BOX 11, AMERICAN MACHINIST.

✝ MISCELLANEOUS WANTS ✝

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d-h'd Lathes & Drills. S. M. York, Clev'd, O.

Koopman's Scales for quick measurements.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Castings of every description and machinery built. Address Cedar Point Foundry, Port Henry, N. Y.

Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Wanted—Machine firm to build and sell my automatic dynamos and motors "Volt," AM. MACH.

For Sale—Patent right of Calipers. Address E. V. Faucett, 14 E. 7th St., Wilmington, Del.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Simonsen-Walter Mfg. Co., Jefferson City, Mo., with modern foundry, machine and wood-work plant, wants spec. to manuf. for Western trade.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

For Sale Foundry and Machine Shop with plenty of orders ahead, in Western town of 7,000 population—coal mining district. Will sell half interest to a good machinist. Address Box 9, AM. MACHINIST.

Yacht Engine Castings, Dynamo and Motor Castings, Model Engines and Electrical Goods. Address, for circular, L. G. Hall & Co., Electricians, 170 Merrimack st., Lowell, Mass.

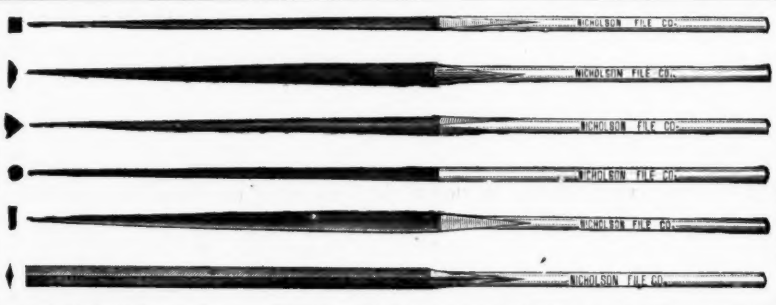
A FACT FOR YOU.

A large manufacturing firm, who had neglected the adoption of a Berryman Feed Water Heater and Purifier in their steam plant, were at last, owing to the cost of fuel, induced to put one in.

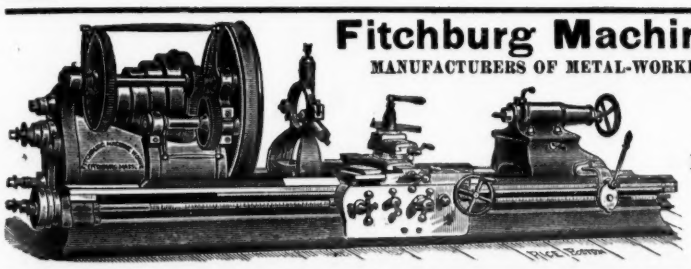
In less than a month they found a saving of over 30 tons of coal. This not only showed a great interest on the investment, but in a few months paid the whole cost of the heater.

BENJ. F. KELLEY & SON,
91 Liberty St., NEW YORK.
SPECIALISTS IN
Feed Water Heating & Purifying.

FILES and RASPS.



PROVIDENCE, R. I., U. S. A.



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MAIN ST.,
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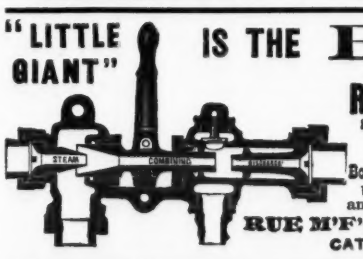

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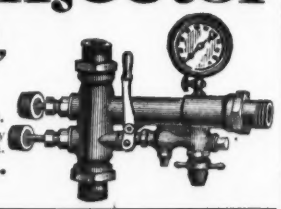
Superior to all others for Raising and Forcing Water and other Liquids.
Boiler Washer and Testing Device.
Uses Warm Water, avoiding injury and facilitating the Raising of Steam.
RUE M'F'G CO., PHILA., PA.
CATALOGUES FREE.



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FOR SALE —A desirable article to manufacture.
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—Which has been well tested.
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—Secured by Patents.
Address, NOTTAD,
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Cooke & Co.'s Special Brands.
ACME, for high speeds and heavy work.
SUPERIOR, for jobbing and general use.
RELIABLE, for shafting bearings for ordinary service.
Write for prices or send us a sample order.
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NEW YORK.

WILLIAM JESSOP & SONS, L'D.
MANUFACTORY, SHEFFIELD, ENGLAND.
Chief American Office, 91 JOHN ST., NEW YORK.
JESSOP'S BEST TOOL STEEL
Cold Medal, Paris, 1889.
ALL KINDS OF Steel in Stock.
Importation Orders Promptly filled.

"Star" Foot Lathe Swings 9x25 in.
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Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes Mortisers.
LATHE
Catalogue Free of all our Machinery.
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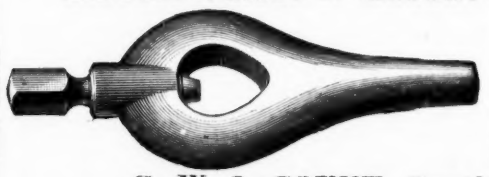
☞ Our New and Revised Catalogue of Practical and Scientific Books, 80 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

REDUCED PRICES OF LECOUNT'S STRAIGHT TAIL DOG.



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No.	INCH.	PRICE.	No.	INCH.	PRICE.
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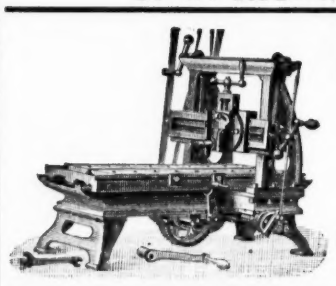
2	⅞	.70	11	2½	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1¾	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set		31.10

C. W. LeCOUNT, South Norwalk, Conn.



SMALL POWER OR HAND PLANER.
FOR ANY SMALL WORK.
Weight of Platen 100 lbs.
A. J. WILKINSON & CO.,
184 Washington St., BOSTON, MASS.
SEND FOR CIRCULAR.

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FOR ENGINEERS AND FIREMEN.
THE BEST BECAUSE
They are written in plain, practical language, devoid of theories or mathematical formulæ.
ROPER'S PRACTICAL HANDY-BOOKS.
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Engineers' Handy-Book.—The most comprehensive and best illustrated book ever published in this country on the Steam Engine, Stationary, Locomotive, and Marine, and the Steam Engine Indicator. Price.....$3.50

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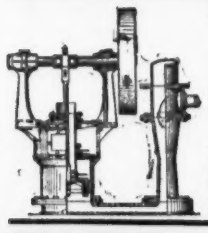

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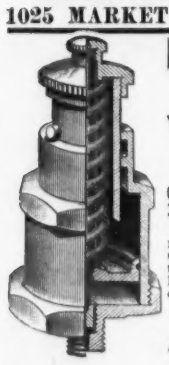

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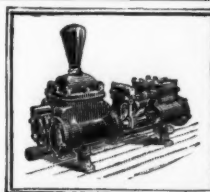

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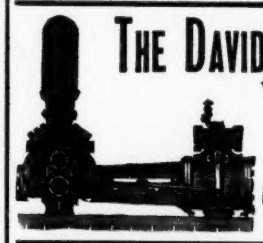

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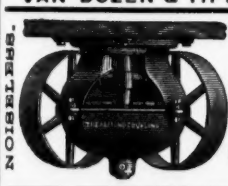

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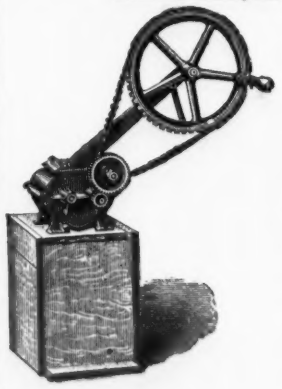

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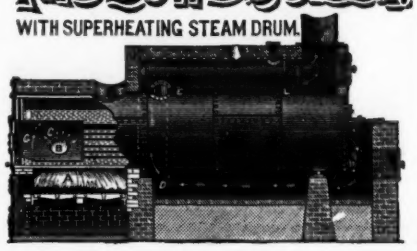

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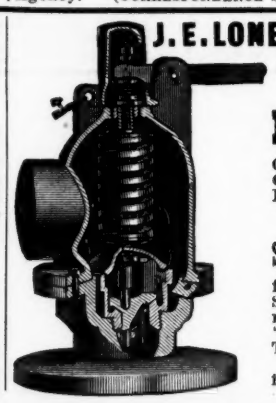

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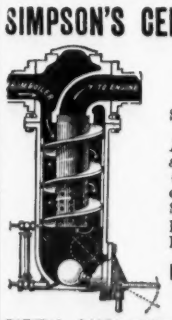

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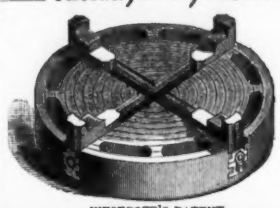

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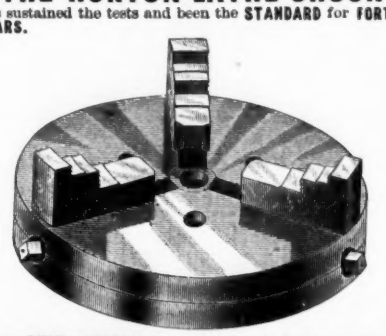

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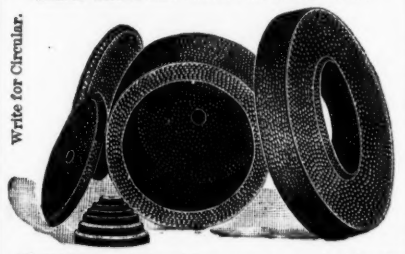

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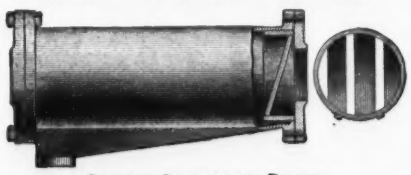

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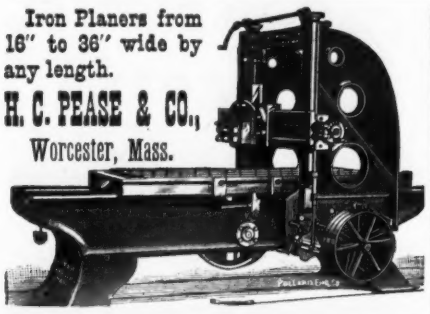

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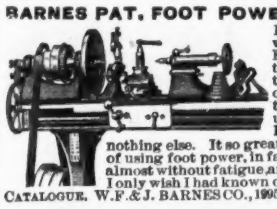

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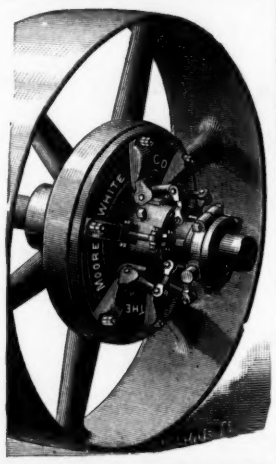

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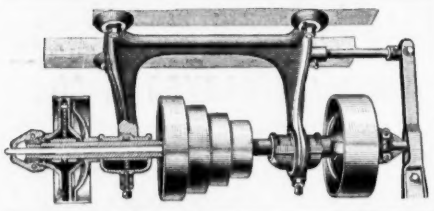

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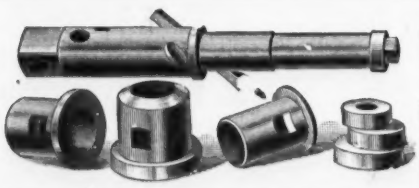

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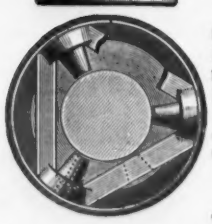

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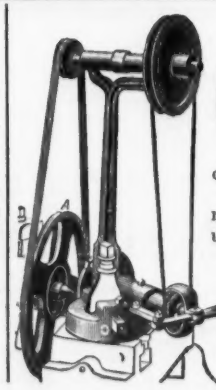

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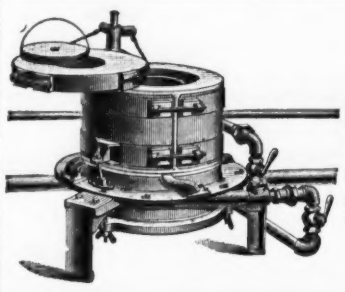

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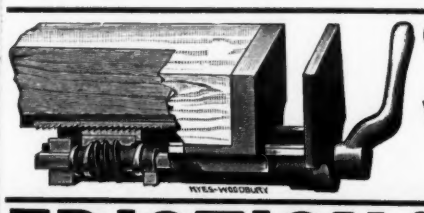

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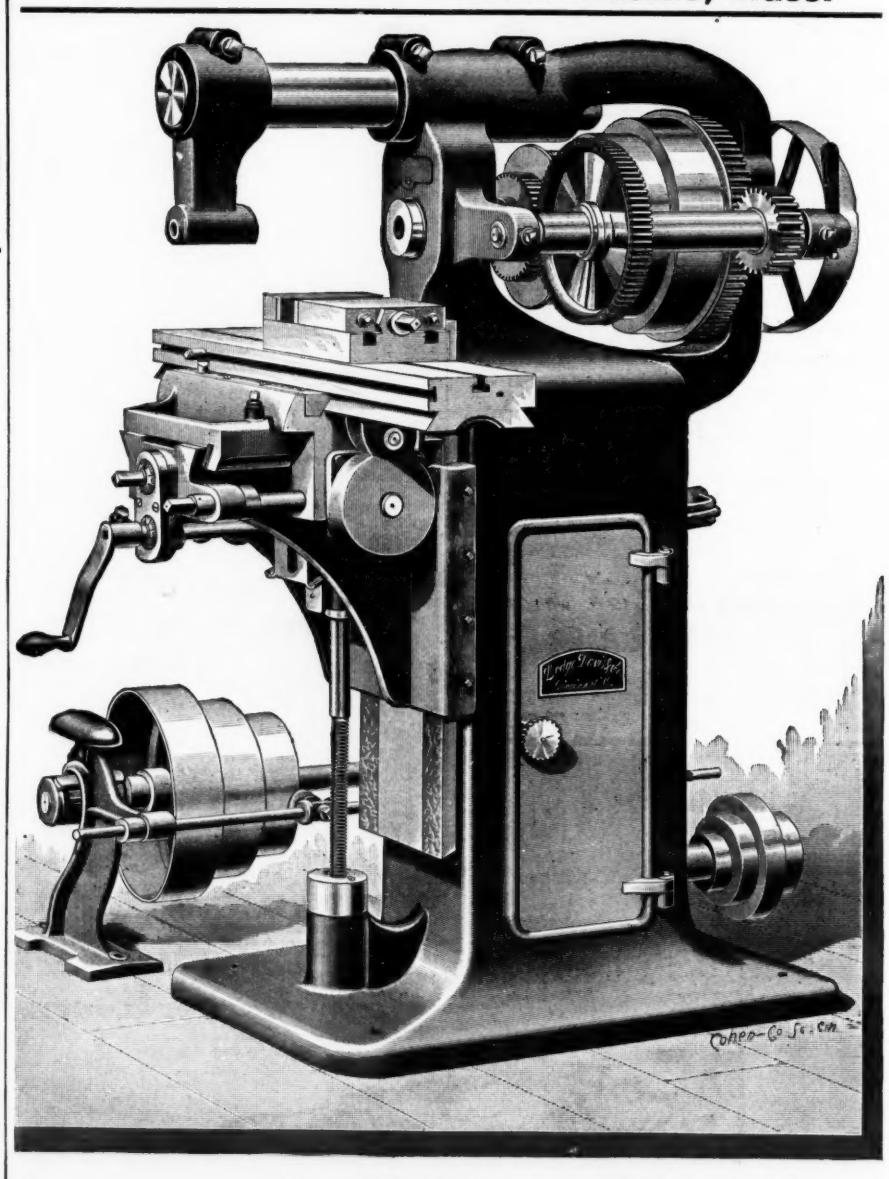

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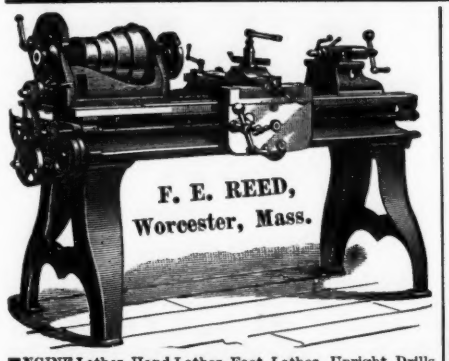

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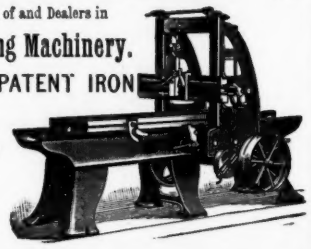

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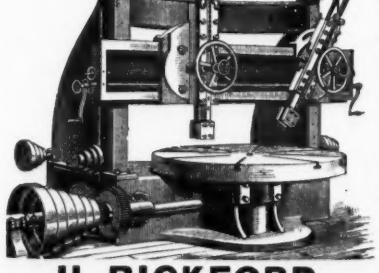

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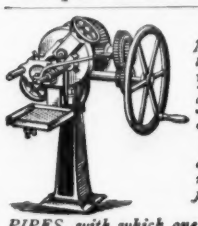

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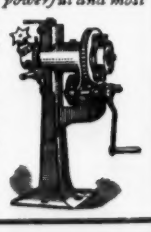

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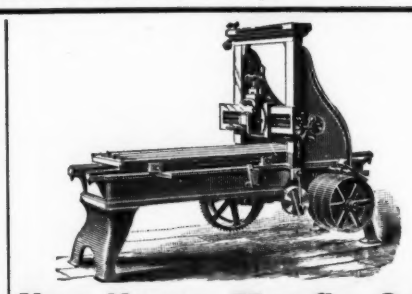

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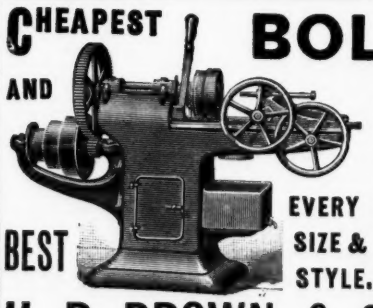

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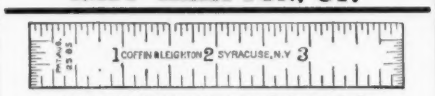

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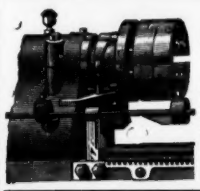

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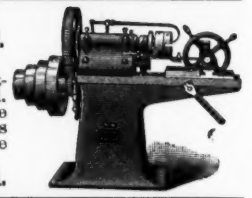

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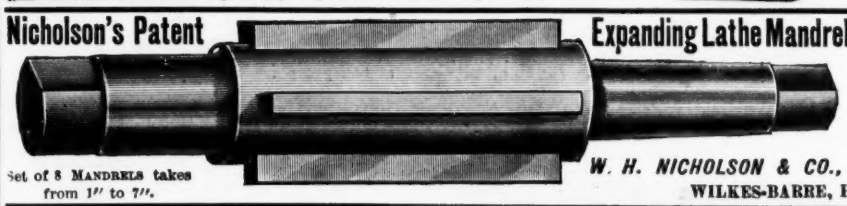

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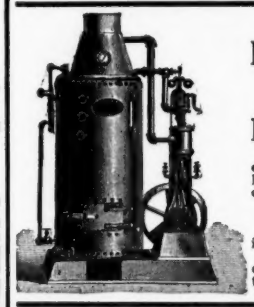

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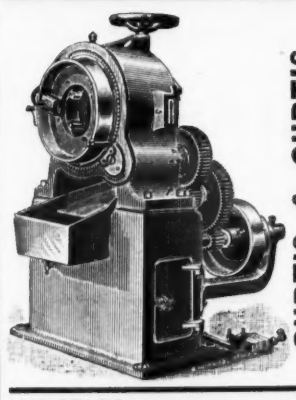

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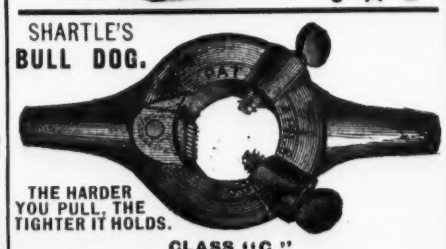

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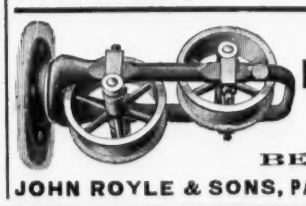

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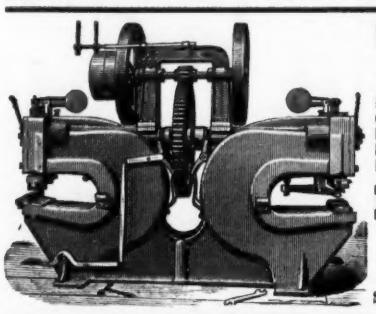

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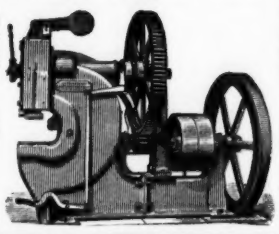

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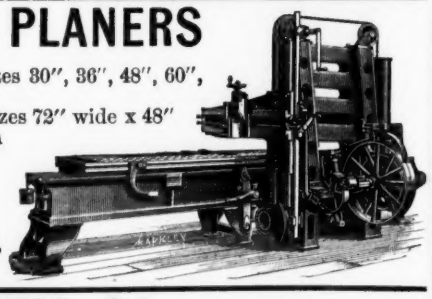

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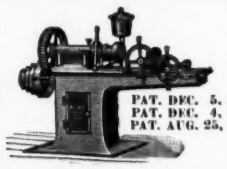

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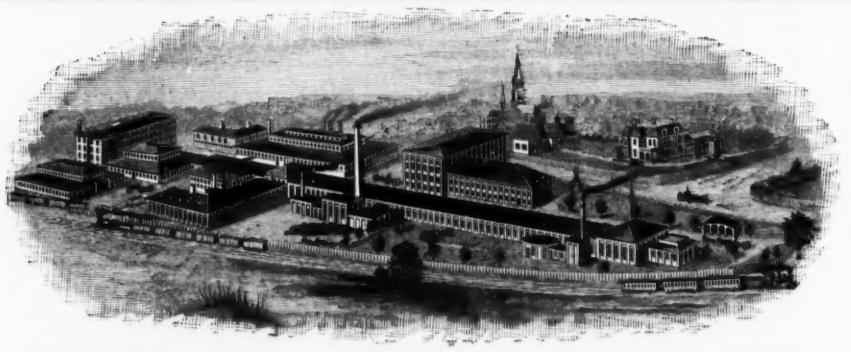

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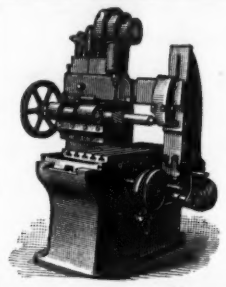

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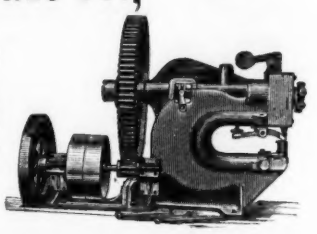

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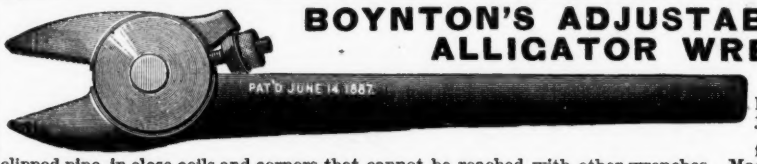

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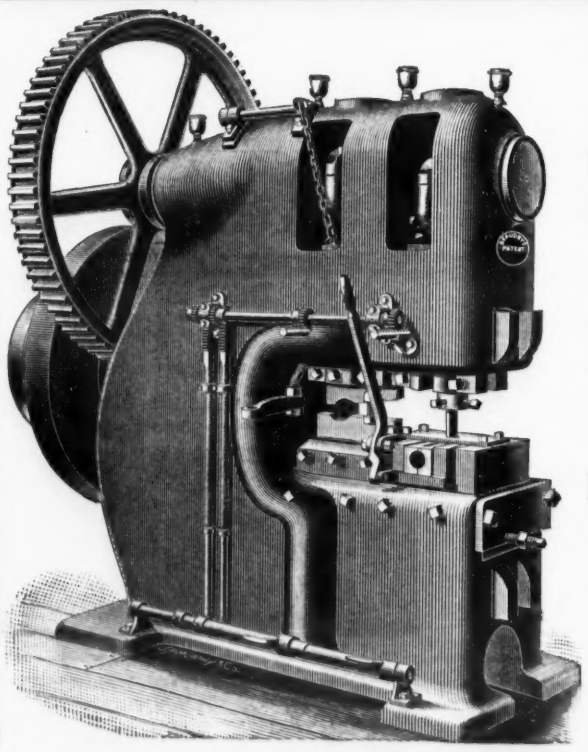

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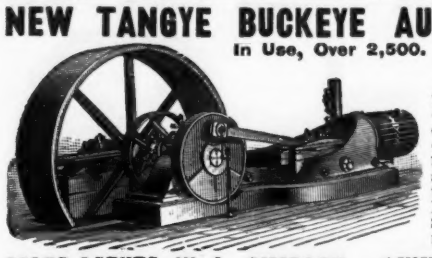

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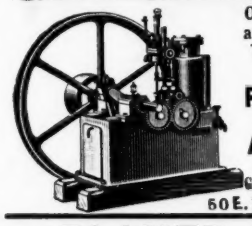

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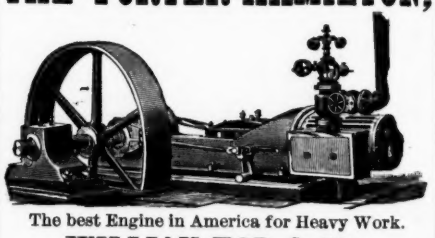

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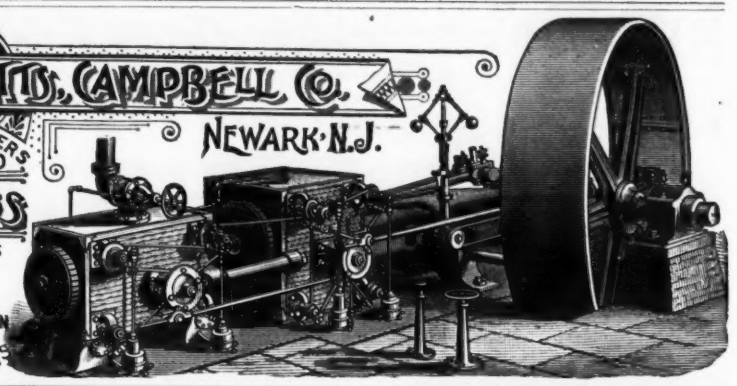

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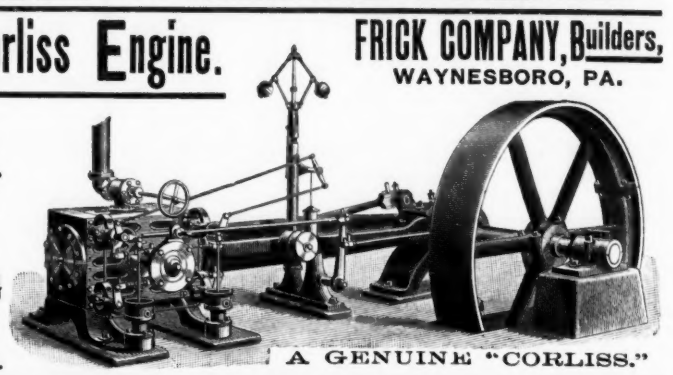

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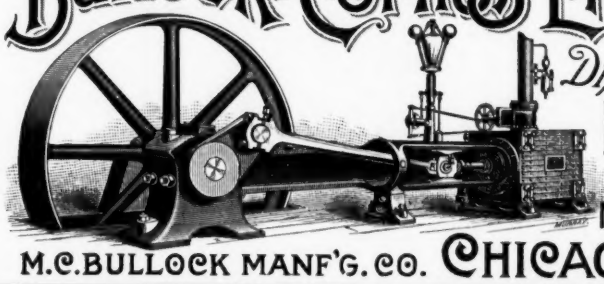

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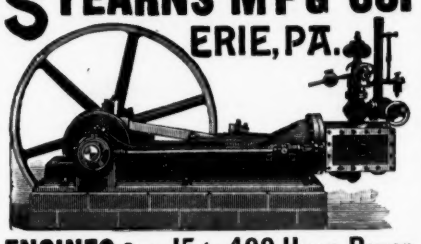

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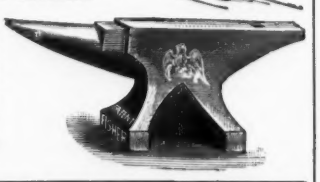

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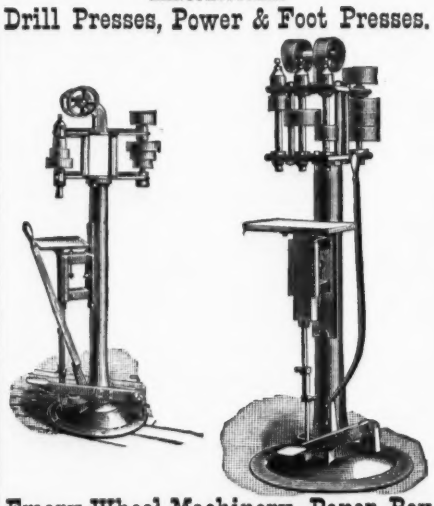

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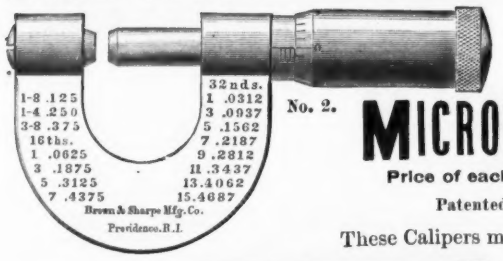

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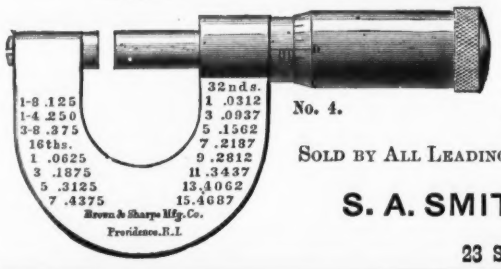

No. 4.

These Calipers measure all sizes less than one-half inch by thousandths of an inch. They can be conveniently carried in the pocket. The No. 2 is suitable for measuring sheet metal, wire, etc. The No. 4 is preferred by many classes of machinists, tool makers, watch makers, etc.

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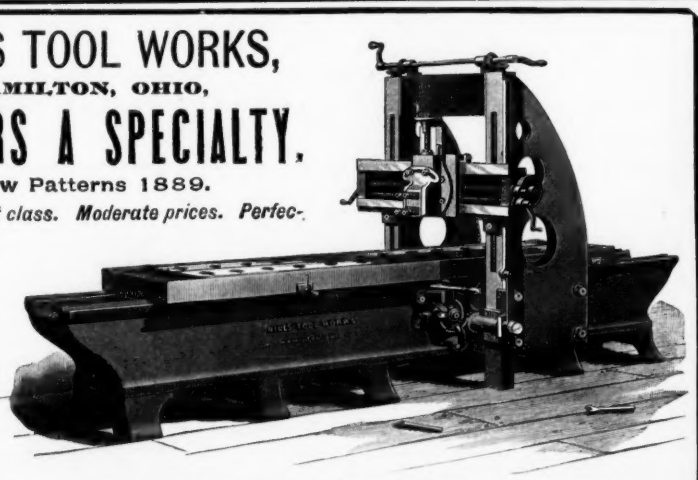

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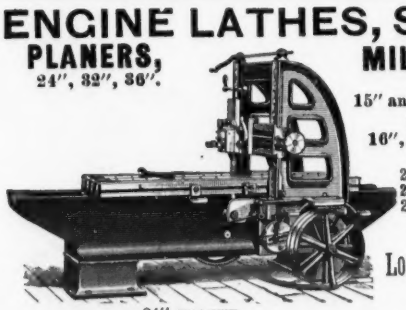

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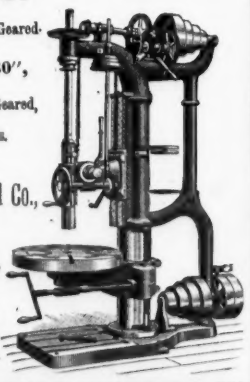

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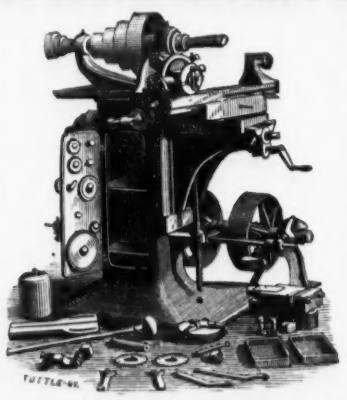

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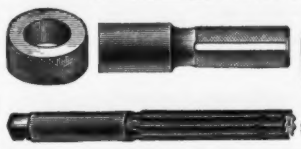

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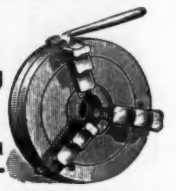

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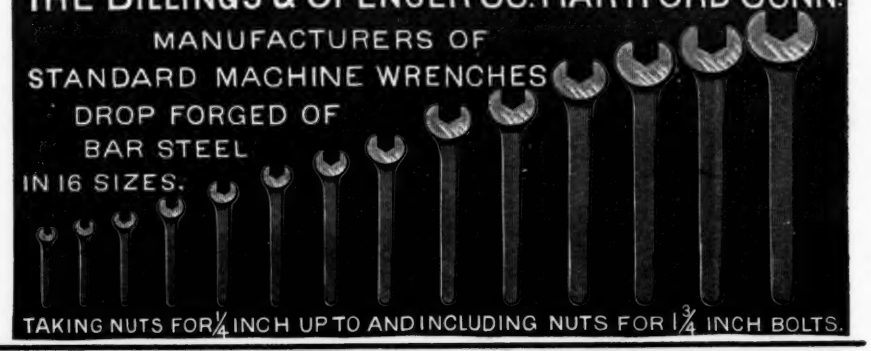

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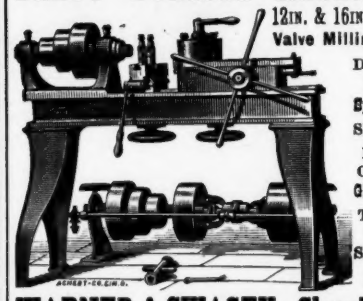

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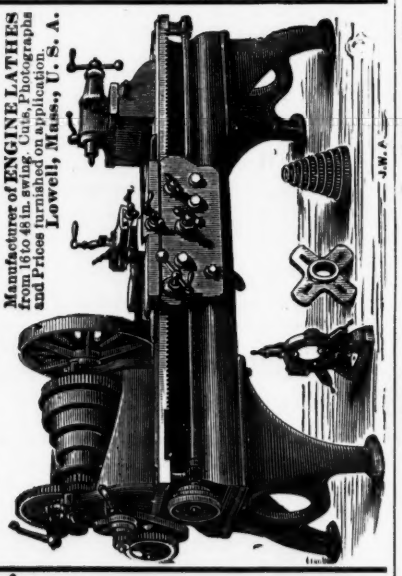

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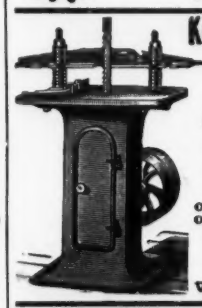

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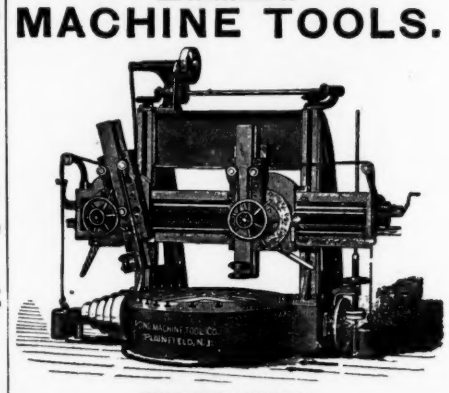

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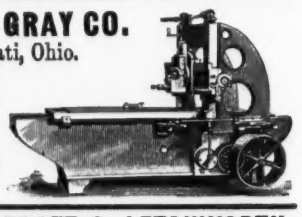

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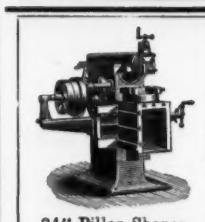

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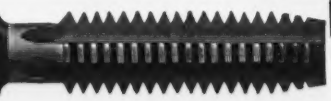

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